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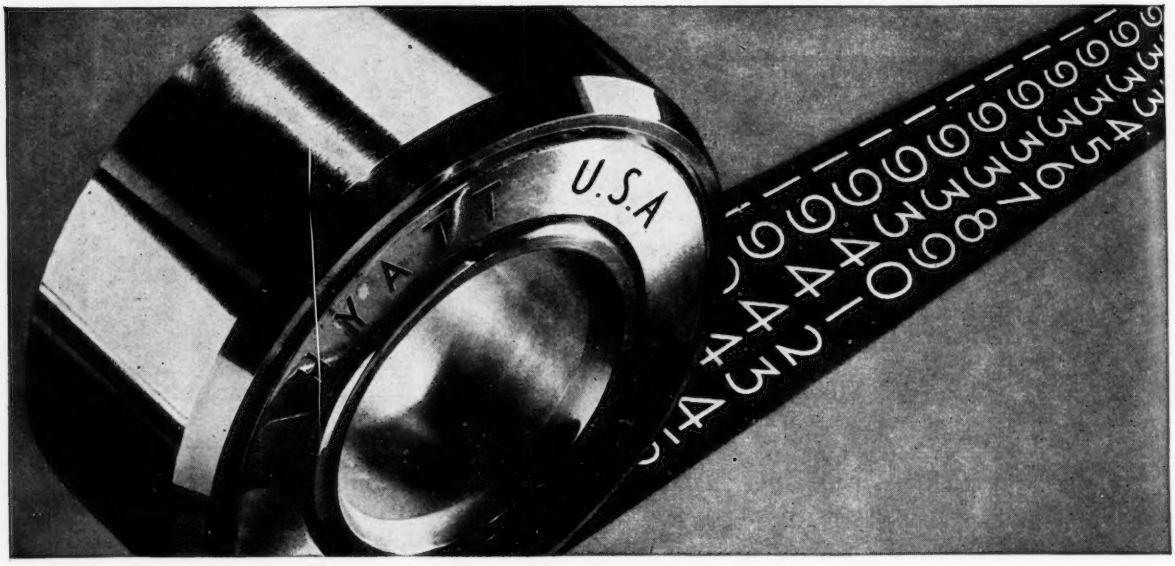

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AGRICULTURAL ENGINEERING

Volume 14 SEPTEMBER 1933 Number 9

Living in the Power Age[1]

By William Boss[2]

WE ARE living in a wonderful period of the world's civilization. We enjoy to a much fuller extent than any of our ancestors a great variety of inventions and developments which human endeavor, skill, and intelligence have made possible. We are living abundantly. Personally, I am very much pleased with the fact that I, as an individual, was born in 1869 and have lived for 63 years in a very interesting part of the world, and have seen many wonderful developments take place, even in that comparatively short period of time. To me the good old times are a pleasant memory, and the good new times are a constant surprise and delight, even better than the old times. If times are worse, it is due to our failure to adjust ourselves and take advantage of the benefits that have become possible.

I am pleased indeed to have this opportunity to talk to you who are especially interested in a farm structures program, for I am convinced that a reasonably energetic home building program, both rural and suburban, will do more to bring us out of the depression than any other one thing, except possibly a wholesome religion, and that would include home building as a very important factor.

During the past three years we have heard a great deal about depression, business failures, bank failures, farm failures, lack of employment, lowering of prices, decreased revenue from taxes, and the surplus of agricultural products. Much thought has been given to the cause of this depression, the length of time it will continue, and the factors by which it is influenced. Leading writers and statesmen have offered many solutions, most of which seem to have been ineffective.

The statement has been made that too much machinery has been invented and that men have been replaced by machines, thus bringing about an unemployment situation. At first thought this in some respects seems logical, and the proper remedy might appear to be in discontinuing the use of machinery. This remedy, however, is more theoretical than practical, for those who have much work to do would soon find that unless they did use machinery which was well suited to the work, their competitors would secure the largest profits and eventually would put them out of business.

It will be well for us to carefully analyze the situation and point out the advantages to be gained by using "machines," as well as the still further advantages of using the so-called "mechanical power" for driving machines, and then endeavor to bring about the adjustments necessary for their continued use in both agriculture and industry. If we can assist in doing this, we may be worthy of being called "agricultural engineers."

MACHINES CHANGE CONDITIONS

The statement that "nature always returns a reward for intelligent effort," may be illustrated in the planting of seed and securing an increase in the amount, as a reward for using both intelligence and effort. Man is rewarded in much the same way for making a tool with which to make his work more effective as in making a hoe or spade, and also in making a machine as illustrated in making a wheelbarrow to help move his burden, taking advantage of the wheel to lessen friction and thus help conserve his own human power or energy. Of course, some work is involved in first securing and planting the seed, or in making the tool or the wheelbarrow, but this work is more than offset by the increase of the seed, or the time which the tool or wheelbarrow will save in doing useful work during its lifetime, especially if it is well made and perhaps made at a time when its maker was not otherwise fully employed. Our first engines were human power engines, such as the battering ram, an engine of destruction operated by cooperative human energy or man power.

We are living in a "power age," a time or an age which gives to us a tremendous productive capacity in all lines, due largely to the accumulated knowledge of such factors as mathematics, physics, chemistry, and biology, and to the fact that we have developed highly skilled mechanics who are able to make machines whereby we may secure power not only from a human being, but also from the wind, water, the ox, the horse, steam, and gasoline—all of which have been provided by the Creator. Were we given only man power with which to operate our machines, machines would not cause unemployment, but in addition to the ma-

[1]An address before a session of the Structures Division of the American Society of Agricultural Engineers during the 27th annual meeting of the Society held at Purdue University, Lafayette, Ind., June 1933. Miscellaneous Series Paper No 277, University of Minnesota, Department of Agriculture.

[2]Professor and chief, division of agricultural engineering, University of Minnesota. Charter A.S.A.E.

terials of nature from which we make machines, we have been given some great invisible "forces of nature," one of which—gravity—enables us to secure power from falling water. This was first used largely for grinding wheat into flour, to make our food more enjoyable. It is necessary for man to construct the water wheel and install it. After doing this, however, his labor ceases to a large extent, except that he is required to protect and keep the water wheel in order. He can thus use the force of gravity for driving his mill, which gives him more time for the greater enjoyment of his "job of living."

We have also learned how to secure power from fire by using and controlling another invisible force of nature, called "chemical activity." Through this activity between the chemical elements we are able to produce heat from coal which we convert into steam power, the development of which has enabled us to find work for people in occupations other than in agriculture. This has raised the type of civilization of all people who have learned to use it. This same force also enables us to secure power from petroleum through our gasoline or internal-combustion engine.

ENGINEERING VIEWPOINT ESSENTIAL

Another wonderful and invisible "force of nature" with which I, as an electrical engineer, am somewhat familiar, is called "magnetism," by means of which we are able to convert power, derived from other sources, into electricity which gives us a very low cost method of transmitting power, as well as giving us automatic controlling devices, thermostats, electric lights, etc., thus making possible a most wonderful standard of living for our people.

The great difficulty at the present time, as I see it, is that our educators, our economists, our bankers, and our preachers are not "engineers." They are not able to see or understand these things as you and I should see them as "agricultural engineers," and until we are able to show them rather plainly and emphatically how these are benefits, blessings, and not curses, and then get these leaders to help adjust our people to the benefits to be had from them, we will be more or less handicapped with what we call a depression. In my opinion, what we most need is "education" of a plain, fundamental, and wholesome character, and to set about to adjust ourselves to the benefits which the proper and full use of these practically "new" forms of power now make possible.

The rapid and remarkable development in farm machinery, building equipment, etc., in the past one hundred years has no doubt resulted from the knowledge men have gained through education together with the skill which they have acquired in making and using tools. Only the technical engineer who is continually in contact with these developments can understand how wonderfully the materials and the forces of nature are correlated, and can be utilized for the benefit of man when men learn to adjust themselves to new conditions which their use brings about. This may be illustrated by the use of fire. It is good for men only when under control, and its use has made necessary the construction of stoves, furnaces, steam boilers, and engines, all of which serve during their construction to give employment to men, but they release men for other activities after they are completed.

Our steam engine was not developed until the year 1769, just 100 years before I was born, when James Watt in England was able to construct a very inefficient one. His difficulty was not only in working out the idea, but also the mechanical difficulty of making the cylinder, piston, etc., accurately enough to produce mechanical motion by the use of steam. This accomplishment brought a great change in the occupations of people. Those engaged in agriculture in England were in a depressed condition at that time, but they benefited by this development as it gave work to the unemployed in industrial lines. This relieved the competition in agriculture and the farmers then secured higher prices for their products.

Many changes have taken place in American civilization in the past two hundred years. These changes have been outstanding; they have affected industry as well as agriculture. As the United States has advanced in prosperity, people have left agriculture and engaged in other industries. This has brought greater prosperity to those engaged in agriculture, who took advantage of modern machinery and improved methods of farming. Apparently agriculture prospers most when a large number of people are engaged in other kinds of industry and industrial wages are relatively high. This tends to hold workers in industry; they are then consumers of farm products, and they provide a market for these products to the farmers who raise them.

Government statistics show that, in the year 1800, 97 per cent of the people in the United States were agricultural. The doctor, the lawyer, and the merchant lived on the land and each kept his own cow, horse, and chickens, as well as a large garden. We had no steam engines at that time; they were just being perfected. There were no railroads and very little machinery. The ox and the horse were the only form of agricultural power other than human power. Ninety-seven per cent is practically all of the people. A rough estimate would indicate that by 1930, a period of a little more than 100 years, about 25 per cent of the people had been taken out of agriculture because of the employment given to them in the development and manufacturing of the steam engine as a producer of power and the machinery which it drives. Generally speaking, about 25 per cent more have been taken out due to the development of the gasoline engine that has provided employment in the building and the operating of gasoline and oil engines, automobiles, trucks, tractors, highways, filling stations, airplanes, etc., and approximately another 25 per cent have been taken out of agriculture and given employment in industry due to the electrical developments that have taken place. This has been due to the knowledge acquired concerning the use of magnetism in the generation of electricity which makes possible the transmission of mechanical power at the present time at the lowest known possible cost. This leaves about 25 per cent of our population engaged in agriculture at the present time. Government statistics show it to be less. What is the complaint of those who are left in agriculture? Some say overproduction; some say under-consumption; some say lack of foreign buying power; some say the tariff; some say the monetary system. Each of these makes itself felt in the present situation, but is it justifiable to say that too much machinery or mechanical power is being used? Surely we agree that mechanical power applied to the farm business and to farm life has made it possible for the individual farmer to produce more and to do it more easily, than in any previous time in history. Under present conditions economical production can not be maintained without the best possible use of mechanical power and equipment. Surely we need to adjust ourselves to the advantages of using mechanical power.

THE IMPORTANT FACTORS

In making an engineering analysis it is very important that we take long-time views both backward and forward and select what seems to be the most important factors relating to the problem. Having selected the most important factors, we should then select other factors which are perhaps of less importance.

I have given considerable thought to the data made available by the eminent Egyptologist, William Flinders Petrie, and from this I have prepared Fig 1 illustrating the development of civilization over a period of the past 7,000 years. This shows the rise and fall of five earlier periods of civilization and the rise of our present civilization which, according to Mr. Petrie, would reach its normal height in about 1930, and if history repeats itself, or if the law of periodicity is not overcome, the present depression will continue until about 2600, when the people then on earth will start to build a civilization which will excel

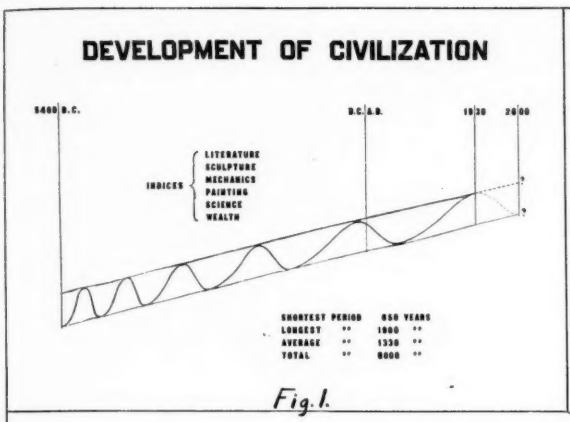

Fig. 1.

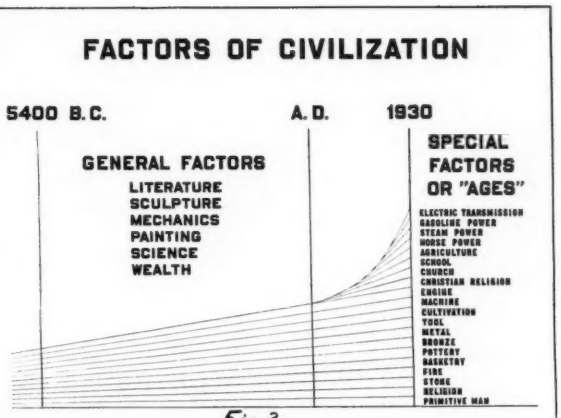

Fig. 2.

APPROXIMATE COST OF POWER USED ON FARMS IN 1930

KIND OF POWER	YEAR INTRODUCED	SIZE OF UNIT	ESTIMATED COST PER H.P. HOUR
MAN	CENTURIES B.C.	1 MAN = $\frac{1}{8}$ H.P.	$4.00
WIND	" "	1 HORSE POWER	.01
WATER	" "	1 " "	.01
OX	" "	1 TO 2 H.P.	.15
HORSE	" "	1 " 10 "	.15
STEAM	1800 A.D.	1 " 30 "	.10
GASOLINE	1890 "	1 " 30 "	.08
ELECTRIC	" "	$\frac{1}{8}$ " 5 "	.08

Fig. 3.

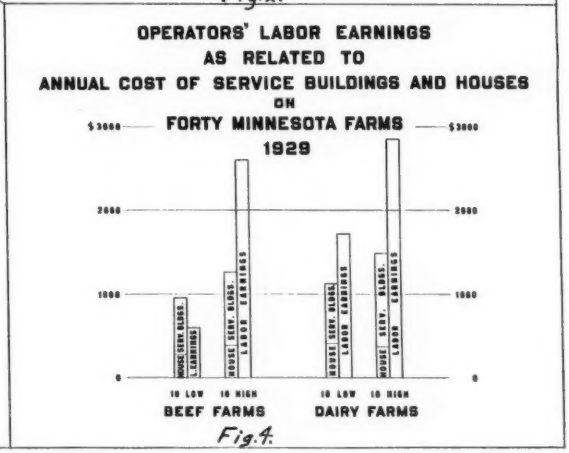

Fig. 4.

ours of the present period. I think the six great factors selected by Mr. Petrie to use as indices were well chosen, namely, literature, sculpture, mechanics, painting, science, and wealth.

Literature is, of course, a forerunner of an educational system. It includes the ability to read and write. Our history, music, etc., are some of its results. Sculpture, a very important factor, would be impossible without human skill to make the tools required and ability to make a true representation. It leads to the ability to make engravings, type for printing, patterns for machinery castings, etc. Mechanics represents human skill and ability to make the things desired. First the tool, then the machine using human power, finally the machines for generating and distributing mechanical power at a very low cost, thus releasing man from his physical burden, provided he develops this skill and ability and adjusts himself to the benefits it gives him. Painting was done before printing; pictures are a universal language. Our best records of history are revealed through them. Painting develops human skill, and if we will include decorating and the painting of buildings and articles for beautifying and preserving them, we will here find a vast field for employment of people as well as a market for linseed oil, etc., which are farm products. Science, the fifth factor, has made an increased rate of progress since the beginning of the Christian era. The science of mathematics is valued by the engineer because it helps to determine exact values and corrects careless thinking or guessing. The laws of physics and chemistry coupled with mathematics may be said to be the tripod upon which engineering rests. Wealth, the last factor, is an accumulation of material things. It is a reward for intelligent effort either physical or mental. I am glad that Petrie put it last, as I believe the others come first, and by the use of them we acquire wealth. Wealth may be in the form of money or in the form of lands, materials, machinery, and buildings, things for which there is a desire.

The rise or fall of a civilization apparently is influenced by the effort the people make in each of these six factors. To neglect any one of them would affect all of the others, as they are all required for a well-balanced progressive civilization. Whether or not, as indicated in Fig 1, the present civilization will continue downward for the next 667 years, or until the year 2600, depends upon the kind of lives our people live. Other factors such as war, the stock market, the price of farm products, and party politics seem to have but little influence upon it. I am hopeful that we will be able to keep our course on an upward trend, but it will require our united efforts to turn its present direction.

SPECIAL FACTORS OR "AGES"

The above six general factors are all-embracing. They are splendid indicators, and they are continuous so far as time is concerned. In order to find, if we can, special factors which seem to have developed and invite our attention, I have prepared Fig 2 showing twenty special factors, or "ages" as we often speak of them, such as the "stone age," "fire age," etc., apparently named from the time at which man first began to use them, or when their use brought about important changes in man's welfare.

The beginning of the first twelve is prehistoric. The primitive man who, probably unconsciously, had a religion of some kind to help him find himself, found help in getting a stone with which to protect himself from an animal and perhaps kill the animal for his own food. This gave

rise to the "stone age" still in existence, and is further supplemented by the fire age, the basketry age, pottery, bronze, metal, tool, cultivation, the machine age with the making of wheels, lever, screws, etc., and the engine age, when machines were made and operated by human or animal power.

Since the beginning of the Christian age eight additional factors appear to have been developed, namely, the Christian religion; the church; the school; scientific agriculture with knowledge of the breeding of plants and animals; the horse power age, where the horse is used to produce rotary power, such as McCormick obtained in 1831 by the horse pulling the cleated wheel of the reaper over the ground and obtaining rotary motion for the reel and reciprocating motion for the sickle; the steam power age, due largely to the efforts of James Watt about 1769, the gasoline power age, which started about fifty years ago, and the electrical transmission age which started about the same time.

Beginning with the improvement of the steam engine by James Watt in 1769, followed by the rotary horse-power, the internal-combustion engine, the electrical transmission of power, and leading up to the present time, a period of only 167 years, in which four out of twenty "ages" have developed, we find we are living in a definite "power age." The other sixteen ages have been thousands of years in developing. Considering the changes, the benefits this recent power age brings to us, I am firmly convinced that it is time for us to realize that adjustments must be made in our educational program in order to teach our people how to adjust themselves so as to enjoy the benefits the use of mechanical power makes possible, and how we may avoid a continuation of the depression which apparently is just getting started on a long-time downward trend. The coming of the "power age" has changed the form of labor man is now called upon to do, and he is not able to compete with mechanical power by means of his physical labor as our grandfathers and grandmothers did, as it had not yet been developed in their time. This is illustrated in Fig 3 showing the approximate cost of power used on farms in 1930, and shows that "man" power is very much more costly than that of the ox or the horse, and still much more costly than steam, gasoline, or electric power. In fact, it proves that man is now worth less than one cent per hour as a producer of power. A one-man-power electric motor can be operated continuously at a cost of less than one cent per hour in nearly any community. Some may say that the cost of man power has decreased since 1930 due to unemployment. If this is true, then it is also true of the other forms of power, as they are all closely related and their cost is based primarily on the cost of "human" ability.

A CHALLENGE TO EDUCATION

In my address as president of the American Society of Agricultural Engineers, delivered in June 1929, I endeavored to point out how the law of periodicity might be overcome, emphasizing the importance of proper education, home ownership, the encouragement of rural and suburban life, shortening the hours of productive labor, and increasing the wage scale of the worker in order that he might become a consumer of products as well as a producer of them. The past four years experience has still more firmly convinced me that this is sound philosophy. We now require the trained individual. He must be educated, or trained and developed, in order to earn a wage sufficient to support and educate a family, to become a respected citizen and appreciate the blessings of having a home, and be willing to pay taxes, the true indication of American citizenship.

The responsibility of the situation is rightly placed upon our educational leaders, those persons who accept public money in return for "teaching" or the supervision of our educational institutions. To curtail educational programs of the proper kind at this time is an indication of ignorance of the purpose of education.

In searching for work for the unemployed there is no other one thing to be found that would be more helpful to all classes of workers and return more satisfaction to our nation as a whole than would an energetic program of home building and home ownership.

To build a home involves the purchase of land, the preparation of the plans, excavating, securing of raw materials from the forest, the mine, the farm, and the factory; the fabrication of these materials and their placement in the buildings; all of this requires skilled workmanship, and skilled workmen together with their families are the best type of consumers of eggs, milk, meat, potatoes, cotton, etc.—all agricultural products for which they are willing to pay good prices if they have a sufficient wage scale. And they thus furnish a splendid market for farm products. If, however, the workers of this class are not kept employed, they are forced to secure a small tract of land and produce their own farm products, thereby not only depriving the regular farmer of his customers but in fact entering into direct competition with him. Agricultural people should therefore encourage a building and improvement program. They should realize that good buildings and equipment on farms are paying investments, and they are fully as necessary as good seed, good tools, good stock, and good machinery.

GOOD BUILDINGS DO PAY

It is false economy to build poorly planned or cheaply constructed buildings, as they cause a serious financial loss through high depreciation, and the additional labor involved in using buildings not properly planned or located. This statement is well proven by a recent study made by the division of agricultural economics and the division of agricultural engineering of the University of Minnesota on forty representative farms to determine the farm operator's labor earnings. The data reveals convincing evidence, as shown in Fig 4, that the twenty farms having the best buildings have returned to their owners the largest earnings for the labor expended. This is scientific proof that good buildings do pay. They not only pay for themselves, but they also enable the operator to secure a larger return for his labor, to say nothing of the pleasure and satisfaction he enjoys while doing his work, a very important factor which is often overlooked. Good buildings are those well suited to the individual farm and the owner's circumstances. A good operator will work better and more efficiently with good buildings. If the buildings are poor, he usually makes them better or he gets another farm to operate.

Good farm homes as well as suburban homes are indicative of high standards of living. There is probably no other one thing that influences the people of a community for the better things of life so much as good homes.

I think I have presented ample evidence that the "power age" has given to us a tremendously increased productive capacity, and I hope I have made it plain that to keep in balance we must increase our consumptive capacity to enjoy its advantages. We must get rid of false theories, learn to waste intelligently, to dispose of things which are inefficient, to encourage the new improvements, to preserve the good and that which is efficient, and to encourage thrift.

Let us as agricultural engineers, interested especially in the Structures Division of our Society, resolve to do our utmost; to use every opportunity, to point out the dangers of the "power age," and the importance of teaching our people how to adjust themselves to its advantages. It is impossible to stop it or to destroy it. It is a blessing in disguise. Let's remove the disguise and spread its advantages throughout the world by building modern homes. Let other nations also profit by its coming and by our example in dealing with it, and let them learn to sing with us, but in their own language, "My country 'tis of thee, sweet land of liberty."

Appraising Improvements in Farm Machines[1]

By J. B. Davidson[2], G. W. McCuen[3], and R. U. Blasingame[4]

AGRICULTURE had its beginnings, according to an eminent authority in archaeology, about 7000 years ago[5]. It was then that man began to depart from the roaming habits of the hunter in search of food, started to build artificial habitations in permanent group settlements, and resorted in a limited way to the cultivation and care of domesticated plants and animals. As soon as man undertook to secure a supply of food from the soil, he devised crude tools to aid him in his work. Samples of these crude tools of husbandry, which changed only slightly during centuries, have been found in the ruins of the human habitations of the prehistoric periods. Sometime later when metals came into use certain simple tools were made of copper and iron. Their development, however, was pitifully slow, and as late as one hundred years ago, the tools and implements of agriculture were still in an almost primitive stage of development. It has been said that, if an Egyptian farmer of Pharoah's time could be reincarnated and put down on a Pennsylvania farm to harvest wheat in the days of our grandfathers, he would have found so little change in the tools of agriculture that he could proceed at once with their use.

Farm machines, which differ from hand tools in that they have various working parts functioning in relation to each other, are of comparatively recent origin. The many influences which led to the rapid development of farm machines, began to be effective in the first half of the nineteenth century as the dates of many of the more important inventions such as the reaper indicate. It was several years later, however, before any general use was made of machines which substituted the energy of animals for human energy. The year 1850 has been designated as the date dividing hand methods of production in agriculture from machine methods.

The number and variety of laborious farm jobs that are now done efficiently with modern machines indicate that great progress has been made during the past century, a comparatively short period of time compared to the long history of agriculture. It is a far cry from the stone hoe to the modern plow with its supplementary machines for preparing a seedbed, from the hoe to the modern cultivating and seeding machines, or from the sickle to the harvester-thresher.

At different times, usually in periods of economic depressions, it has been contended in various quarters that the application of engineering science to agricultural production has run its course, and in some instances it has been suggested that there must be a recession. As an example of such a view, consider the following excerpt from an article printed in the "Forum" of April 1894[6]: "We are now in a transition period in agriculture. The influence of machinery has been fully exerted. It is doubtful if the next century will see any new important inventions that will further eliminate the man from the land." This prophecy is called to the attention of those who now insist that we have reached the end of progress and are entering a period of recession or decline.

The present paper deals with a recent study of the advancement made in improving farm machines during the past twenty years, or from 1910-14 to 1932. That inquiry was prompted by a desire to correct an impression prevailing in certain quarters that such farm machines as binders, mowers, rakes, etc., of twenty years ago are identical with similar machines of today. This impression might be attributed to the fact that in many cases these machines have not been greatly altered in general appearance during this period. The improvements which have been made are all of a strictly utilitarian character, no program having ever been undertaken merely to improve the machines in appearance, style, or beauty. Certain machines have several thousand component parts, all of which

[1]Paper presented at a session of the Power and Machinery Division of the American Society of Agricultural Engineers during the 27th annual meeting of the Society held at Purdue University, Lafayette, Ind. June 1933. This paper was intended as a review and discussion of a report prepared by the authors, entitled "Report of an Inquiry into Changes in Quality Values of Farm Machines between 1910-14 and 1932," and published by the Society in June of this year.

[2]Professor of agricultural engineering, Iowa State College. Charter A.S.A.E.

[3]Professor of agricultural engineering, Ohio State University. Mem. A.S.A.E.

[4]Professor of agricultural engineering, Pennsylvania State College. Mem. A.S.A.E.

[5]N. C. Nelson. The Origin and Development of Material Culture. Sigmi Xi Quar. Vol XX, No 3. September 1932.

[6]E. V. Smalley. Has Farm Machinery Destroyed Farm Life. Forum Vol 17. April 1894.

The invention, subsequent development, and extended use of farm machines has been recognized as one of the most significant influences contributing to the advance of agriculture and the progress of civilization. In a broad sense the introduction of farm machines or mechanization represents application of engineering methods to agriculture, since engineering deals largely with the scientific problems of applying power by means of machinery to increase the effectiveness of human labor.

have been notably improved in qualities that are apparent only to those who will take the necessary time to examine them part by part and assembly by assembly.

A second purpose which prompted the inquiry was the expressed desire for such data by federal government bureaus, statistical societies, and colleges which in the past have been comparing prices of manufactured products of twenty years ago with those of today, without making any corrective calculation to provide for changes in the quality of such products from year to year[1].

In November 1932 the authors—all three members of the American Society of Agricultural Engineers—were requested to conduct this inquiry. The authors were then and are now engaged in agricultural engineering education in state colleges, and are not connected in any way with the farm equipment industry. The National Association of Farm Equipment Manufacturers made a request to their respective institutions that they be permitted to make the study. They were given permission to do so and served without compensation.

The report of this inquiry has been published by the American Society of Agricultural Engineers and is available by purchase at the Society's headquarters at St. Joseph, Michigan. It consists of four parts: (1) The report proper is an analysis of quality values, an outline of the significant changes in the design and construction of farm machines and a summation of the data in the form of quality index numbers; (2) a chronological record of the changes in the twenty-five farm machines, during the period under consideration; (3) a discussion of materials used in farm machines and records of laboratory tests, and (4) full-page illustrations of machines and parts with changes numbered and described in detail in the accompanying text. It is not the purpose of this paper to repeat any of the findings which may be obtained from the report, but rather to discuss more particularly the authors' methods and to outline a few suggestions of methods which may be used in the future for evaluating or appraising the changes made in such manufactured products as farm machines.

THE MORE IMPORTANT FEATURES OF THE AUTHORS' INQUIRY

The more important features of the authors' program in making the inquiry were as follows:

1. The examination of twenty-five typical 1910-14 farm machines and twenty-five corresponding 1932 machines and their component parts.

2. The assembly of exhibits of parts representing important changes in construction or materials.

3. Study of the chronological records of important changes made in each machine and parts thereof during the period of the inquiry.

4. Examination of records of comparative repair part sales for machines of these twenty-five types during the period covered by the inquiry.

5. The review of laboratory test data furnished by the engineering departments of manufacturers.

6. The making of additional laboratory tests for strength resistance to abrasion, durability and performance.

7. Interrogating designers, service engineers, and others familiar with design, construction, and operation of machines.

8. Computation of comparative energy or power requirement of machines for each unit of work accomplished.

9. The making of an analysis of the specific ways in which a machine may be improved.

10. Evaluating and appraising the changes observed, reducing the results to the simple form of index numbers and writing a report of the inquiry.

It is to be noted that the inquiry was confined entirely to a study of the characteristics which affect the value of the machine to the user in carrying out the operations or purposes for which the machine was designed. An analysis of the ways in which farm machines may be and have been improved resulted in the segregation of the following kinds or forms of improvement which for want of a better term may be called quality factors:

FORMS OF IMPROVEMENT DESIGNATED AS "QUALITY FACTORS"

1. **Durability.** Greater service from machines, measured in such units as acres plowed, cultivated, etc., bushels harvested, etc., during potential life of machines.

2. **Resistance to Wear.** Reduction in the required amount of replacement, adjustment, or conditioning of wearing parts, such as cutting edges, chains, gears, etc.

3. **Continuous Performance.** Freedom from delay due to clogging, choking, heating, etc.

4. **Freedom from Breakage.** Increased strength of component parts considered both separately and in their respective assemblies.

5. **Efficiency in the Use of Energy.** Reduction in amount of energy required for each unit of work performed.

6. **Increased Capacity.** Enlarging capacity of machines of given size so as to handle more work, to be operated at a higher speed, etc.

7. **Operating Efficiency.** Increasing degree of effectiveness in operation, such as threshing and cleaning efficiency, weed destruction, etc.

8. **Operating Precision.** Increased accuracy in performing such work as planting the correct amount of seed at uniform depth, etc.

9. **Reduction in Time Required to Care for Machine.** Saving of time for lubrication and adjustment by introducing grease cups, Zerk oilers, inclosed gears which exclude dust and dirt, high-grade roller and ball bearings, etc.

10. **Greater Safety.** Reducing hazards to life and limb with attendant financial loss and economic waste.

11. **Increased Ease of Operation.** Reduction of physical energy expended in operating machines.

12. **Greater Comfort in Machine Operation.** Increased efficiency of operation through protection from dirt, heat, excessive vibration, etc.

The appraisal of any improvement in a farm machine requires a basic knowledge of the economics of farm machine operation and detailed practical knowledge of the use of such machines. Every farmer when confronted with the problem of purchasing a farm machine has a similar appraisal to make. The committee has found the experience of making the scientific appraisals involved in this inquiry exceedingly interesting as well as instructive. One of the main purposes of the present paper is to encourage further intensive research along these lines.

The American Statistical Association has a committee at work inquiring into the relationship of quality changes and price changes of manufactured goods. One member of that committee recently stated that the members were all much interested in the question of how to take account of quality changes in relation to price changes. He added, "I hope that the committee or some other body will be able presently to work out a satisfactory general technique for taking account of such changes. If and when that is done I certainly favor price indexes which take account of them."

The authors of the "Report of an Inquiry into Changes of Quality Values of Farm Machines Between 1910-14 and 1932" have approached their problem from both the scientific and practical viewpoints. The report is, they hope, a practical contribution to the solution of a very practical question. It is the authors' opinion that, to make a satisfactory qual-

[1] Index Numbers of Prices Paid by Farmers for Commodities. Bureau of Agricultural Economics. U. S. Department of Agriculture. Wholesale Prices. Bureau of Labor Statistics, U. S. Department of Labor.

ity value appraisal, it is essential that the investigators have an intimate practical knowledge of the engineering, manufacturing, field operating, and economic aspects of the machines to be studied.

For the purpose of checking the index numbers of quality value arrived at by the whole committee, the authors offer the following suggestions concerning a technique for appraising the changes in quality value of farm machines.

The economics of modern agricultural production involves the following important items:

1. Economy in the use of energy
2. Economy in labor expenditures
3. Cost of machine service
4. Quality of work performed.

Although Items 3 and 4 are important and essential, they do not have the same relation to the cost of carrying out farm operations as Items 1 and 2. It is a matter of common knowledge that power and labor make up from 40 to 60 per cent of the cost of producing most agricultural crops, thus a slight gain in economy in these items materially affects the total cost of production. On the other hand, the cost of machine service is in itself not a large item for most crops. For instance, in the growing of corn in the corn belt the cost of machine service should average about five per cent of the total cost of production. Of course tractor cost is considered as an item of power cost. The quality of the work performed by the machine may be very important, even to the extent of determining whether the machine is practicable or not.

THE APPROACH TO AN APPRAISAL OF A FARM MACHINE IMPROVEMENT

A simple way to approach the appraisal of a farm machine improvement is to determine by research or from existing data the power, labor, and machine costs under normal average conditions and estimate the annual savings possible with the new design. The saving in power is, as already stated, a vulnerable point of attack in seeking economy. Efficiency in the use of power, as applied to an ensilage cutter, may be used as an illustration. In 1910-14 according to the data available to the authors, three-fourths of a ton of cut ensilage per horsepower-hour was the usual output[8]. In 1932, due to improved blower design, use of friction-reducing bearings and other improvements, an output of one ton of silage per horsepower-hour was generally obtained. Thus, if a silage cutter having a capacity of 15 tons per hour required 20 hp to operate in 1914 and 15 hp in 1932, there was a saving of 5 hp. If the working day be 10 hours and the use of a silage cutter per year be seven days[9], the annual saving would be 350 hp-hr. Now the value of this energy may be computed, say, at 5 cents per horsepower-hour giving an annual saving of $17.50 per year. This may be expected to continue the entire life of the machine which under normal conditions has been found to be 10 years[9]. The present worth of such an annual saving may be obtained from compound interest tables. In this case it would be proper to start with the first increment. If interest at 7 per cent be assumed, the present worth of an annuity starting with $17.50 and continuing for nine additional annual payments would be $131.56[10]. Suppose this present value of the saving be related to the first cost of an ensilage cutter. If a first cost of $350 is used as a base or as an index figure of 100, the increased capacity per horsepower-hour would have an index of 100 + (131.56 ÷ 350) = 138 from this factor alone.

In like manner the annual value of the labor saved by the new machine may be estimated. Labor may be saved in several ways, for example: Less time lost in operation; increased capacity, thus reducing the labor per unit of output; and reduction in time required to service, repair, operate, and adjust the machine. Suppose these savings amount to a total of 25 hours per year. This can be evaluated at a customary rate per hour. The present worth of this annual saving may be determined as before and related to the first cost of the machine.

Greater durability affects the largest item in the cost of machine service, generally referred to as depreciation. The life of farm machines varies widely, but several studies have been made of the life of farm machines during the past 25 years and methods of computing annual depreciation charges, or the cost of machine service for each unit of work done, have been arrived at.

An important item in the cost of farm machine service is the cost of repair parts required on account of wear or breakage. The farm equipment manufacturer's system of studying the demand for repair parts as a guide to the improvement of materials and design of parts which require frequent replacement, has made it possible to substantially reduce this item of expense. In certain machines the annual cost of repairs has been reduced from about five per cent to less than one per cent of the first cost. This annual saving can be evaluated for the life of the machine and reduced to an index number.

SUBSTANTIAL REDUCTION IN ANNUAL COST OF FARM MACHINE REPAIRS

Increased capacity has a direct bearing upon the cost of machine service. A machine of a given size which has double the capacity of an older machine may not only reduce the labor, as previously explained, but may also cut the cost of service in half, assuming it has a life equal to the old machine measured in days used or years of operation.

Such factors as operating efficiency and precision can be appraised quite accurately for certain machines, while for others these qualities are more difficult to evaluate.

Factors such as safety, ease of operation, and comfort, are extremely difficult to appraise although they have a very definite quality value.

After considering and appraising the changes which have taken place in each of the quality factors and reducing the results to an index number, a combined index number may be made by proper weighting and combining of all of the individual numbers. Throughout the entire procedure a practical knowledge of the machines and their use must be depended upon in order to reach an accurate conclusion.

The inquiry with which this paper deals should prove to be the beginning of a movement which will, through the combined effort and study of engineers, economists, and statisticians, evolve a practical technique of quality value appraisal, based upon sound economics and engineering. Such a development ought to be helpful in clearing up misconceptions about the economic value of certain features of farm machines. It should also lead to a more definite appreciation of changes that have real merit and may have a definite influence upon the course of improvement and design.

The authors feel that they would be remiss if they did not report how much they were impressed with the improvements which have been made during the past twenty years in the farm machines studied. The authors have had continuous contact and experience with farm machines during this period, but a progressive development is naturally not so impressive as direct comparison of the old with the new. Many of the men connected with the engineering departments of the various manufacturers were likewise impressed when the 1910-14 and 1932 machines and their parts were all laid out for comparison, each with each.

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[8]F. W. Duffee. "Testing the Efficiency of Silage Cutters." Trans. Amer. Soc. A. E. Vol 17. Dec. 1923.

[9]J. Brownlee Davidson. "Life Service and Cost of Service of Farm Machines." Bul 92. Ia. Eng. Sta. June 1929.

[10]James W. Glover. "Compound Interest and Insurance Tables." George Wahr Publisher. 1928.

Spacing of Row Crops in the United States[1]

Results of a survey made by the A.S.A.E. Committee on Row Crop Investigations

STANDARDIZATION of the multiplicity of spacings in the planting of row crops as they are in use today would be a valuable contribution to both the equipment manufacturer and the grower. This variety of spacing is largely the result of custom or habit, rather than scientific study. Work carried on at the various agricultural experiment stations indicates that the spacing between the rows of crops and of the plants within the rows may vary greatly without materially affecting the yield. Manufacturers have a real problem in trying to supply machinery to meet the demands of the various row spacings as they are now practiced.

The material for the survey, on which this report is based, was secured from questionnaires which were sent out to all the state agricultural colleges and to the branch houses of a number of the leading farm implement manufacturers. Replies were received from 44 state colleges and from 85 branch houses.

Twenty-three crops were tabulated from the questionnaires, including both field crops and vegetables. In tabulating the results, a crop was not listed for a state unless there was at least 1000 acres. The acreage figures were taken from the state reports when given, otherwise from the 1930 census.

Table I shows the summary figures for the 23 crops. The acreage, method of planting, most common spacing, and variation in spacing are the points of special interest in the table. The ten leading row crops in the United States and their acreages are shown in Table II. Table III shows the total acreage of row crops and the number of different row crops grown in each of ten states having the largest row crop acreages. It is interesting to note that Texas has 1000 acres or more of twenty of the 23 crops listed in Table I.

[1]Report presented at a session of the Power and Machinery Division of the American Society of Agricultural Engineers during the 27th annual meeting of the Society held at Purdue University, Lafayette, Indiana, June 1933.

An examination of the method of planting the various crops shows that all crops are planted both on level ground and on ground that is ridged. This means that every state uses some of the special machinery for handling row crops planted on ridges or in furrows.

For the cultivation of the crops, sweeps are listed by every state, and their sizes run from quite narrow widths up to 36 in in width. Other methods of cultivating use the

(Continued on page 244)

Table II. The Ten Leading Crops in Order of Greatest Acreage

Corn	105,455,417
Cotton	47,227,488
Sorghum (grain)	5,303,082
Potatoes (Irish)	3,100,366
Tobacco	1,886,925
Peanuts	1,757,449
Beans (field)	1,672,844
Soybeans	1,029,218
Beets (sugar)	790,251
Potatoes (sweet)	770,140

Table III. States Having the Ten Largest Row Crop Acreages

State	Acreage	Number of different crops
Texas	24,508,100	20
Iowa	11,390,855	13
Arkansas	10,992,852	16
Illinois	9,716,084	14
Nebraska	9,361,358	5
Oklahoma	8,139,670	15
Georgia	8,114,044	15
Kansas	7,703,642	10
Florida	7,031,387	14
Missouri	6,711,876	17

Table I. Survey of Row Crops Grown in the United States and Machinery Requirements (1930)

Crop	Acreage* for U.S.	Plowing depth, inches	Method of planting**	Spacing between rows: Most common spacing, inches	Spacing between rows: Variation in spacing, inches	Cultivation: Depth, inches	Cultivation: Number of times	Average times cultivated	Implement clearance necessary, inches
Beets (sugar)	790,251	4 - 14	1,2,3	20	16 - 36	1 - 6	2 - 8	4.50	12 - 18
Beans (field)	1,672,844	3 - 14	1,2,4	30	20 - 48	1 - 4	2 - 6	3.70	8 - 31
Beans (green)	125,205	4 - 10	1,2,3	30	18 - 42	1 - 4	2 - 6	3.66	9 - 36
Corn (field)	105,455,417	3 - 12	1,2,3,4	42	30 - 120	1 - 6	2 - 7	4.25	18 - 42
Corn (sweet)†	479,059	4 - 9	1 2	42	24 - 48	1 - 5	2 - 7	3.80	21 - 42
Corn (broom)	339,081	4 - 9	1 4	42	36 - 84	2 - 3	2 - 5	3.50	18 - 30
Cabbage‡	155,727	3 - 12	1,2,3,4	36	24 - 44	1 - 5	2 - 10	4.48	8 - 36
Cantaloupe	133,747	4 - 10	1,2,3	60,72	36 - 108	1 - 5	2 - 6	3.80	6 - 18
Cotton	47,227,488	3 - 14	1,2,3,4	42	30 - 60	1 - 5	3 - 15	5.30	18 - 36
Cucumber	117,048	3 - 10	1,2,3	60	24 - 96	1 - 5	2 - 7	3.60	6 - 25
Onions‡	82,381	4 - 10	1 3	14	12 - 60	1 - 4	2 - 10	4.70	8 - 24
Peanuts	1,757,449	4 - 10	1,2,3,4	36	24 - 48	1 - 4	2 - 6	3.60	12 - 36
Potatoes (Irish)	3,100,366	4 - 12	1,2,3,4	36	24 - 46	1 - 10	3 - 12	4.28	12 - 36
Potatoes (sweet)	770,140	4 - 10	1 2,3	36	30 - 60	1 - 8	2 - 6	3.80	6 - 36
Peas (green)	131,078	4 - 10	1 2,3	36	10 - 42	1 - 4	1 - 7	3.40	12 - 36
Sorghum (sweet)	240,355	5 - 12	1,2 3,4	48	34 - 60	1 - 5	2 - 6	3.30	18 - 36
Sorghum (grain)	5,303,082	3 - 9	1,3,4	42	36 - 84	1 - 5	1 - 5	3.10	18 - 36
Soybeans	1,029,218	3 - 10	1 2	30,36	12 - 42	1 - 5	2 - 6	3.41	12 - 36
Strawberries	179,879	5 - 12	1 2,3	36,48	24 - 60	1 - 5	1 - 10	4.17	4 - 21
Sugarcane	275,876	4 - 9	1,4	42	36 - 84	2 - 3	2 - 5	3.50	18 - 30
Tobacco	1,886,925	4 - 10	1,2,3,4	42	20 - 60	1 - 5	3 - 8	4.68	18 - 36
Tomatoes	464,537	3 - 10	1,2,3,4	48	24 - 96	1 - 6	3 - 8	4.47	12 - 36
Watermelon	257,153	4 - 10	1,2,3	120	48 - 240	1 - 5	2 - 6	3.78	5 - 32

*Acreage taken from U. S. Census and state reports; all figures subject to correction.
**(1) on level ground; (2) on ground slightly ridged; (3) on ridges; (4) in furrows.
†Limited information secured. In general, cultural practices used for field corn are followed, except that sweet corn is drilled.
‡Some crops have a number of hand cultivations, some of which are included.
NOTE: Table compiled by R. I. Shawl.

A Review of Results of Dielectric Methods for Measuring Moisture Present in Materials[1]

By N. E. Edlefsen[2]

THE dielectric constant of material is always determined by measuring the capacity of a condenser having the medium between its plates. (In this discussion the medium used was assumed to be an insulator. If it is a conductor, the capacity of the condenser may be measured by any one of several special methods. As space will not permit an explanation of these methods here, the reader is referred to another discussion by the author[3] and to other references given.)

The dielectric constant of materials varies widely. Some of the values are listed in Table I. Because the dielectric constant of water is very much higher than that of any other material listed, changes in moisture content may be detected in any medium which is placed between the plates of a condenser. The condenser must be calibrated for the given material to obtain a quantitative measure of the change in moisture content.

The dielectric constant of conducting solutions has received considerable attention by investigators with somewhat conflicting results. The recent work of Lattey[4,5,6] and his co-workers, however, is probably the most accurate available. Their determinations[6] regarding the effect of temperature of the dielectric constant of pure water appear in Fig 1. Their results also indicate that the temperature coefficients of the dielectric constant for sugar and salt solutions have magnitudes of the same order as does pure water.

Their measurement of the variations[5] in the dielectric constant at 18 deg C as a function of electrolytic concentration is shown in Fig 2. Berliner and Ruter[7], investigating the dielectric constant of inorganic sclutions, found it a useful means of determining how much water is present in solution.

Burton and Pitt[8], having developed a dielectric method of determining moisture in wheat, claim for it certain advantages over other methods. They find that no weighing is necessary; the determination requires only a few minutes. Their apparatus not only is strong and portable but it requires no artificial heating. Readings are practically independent of temperatures above 0 deg C. Some results obtained by Burton and Pitt on No 3 Northern wheat are shown in Fig 3, where the deflection of the condenser on their apparatus is plotted against the per cent moisture as determined by the Brown-Duvel method. This method consists of boiling a known weight of wheat in oil which has a high boiling point, condensing the water driven off, and measuring its volume.

Davies[9], also, has used a dielectric method of determining the moisture content of seeds, with fair results on some varieties. He found difficulty, however, in getting consistent packing of certain seeds, that is, in getting the same amount of dry seed in the condenser each time a test was made.

Berliner and Ruter[7,10,11] have made use of a dielectric method in studying moisture in grains and grain products.

A device is now offered for sale in the United States which purports to measure moisture content in grains by the dielectric method. So far as I know, however, no results of tests on it have been published.

Balls[12,13] has done considerable work on testing the moisture content of cotton bales by a dielectric method which he considers fairly successful. In the brief paper mentioned here, he promises a more complete report. He used the bale-hoops as the plates of the condenser.

Balls[13] reports results obtained with condenser plates buried in the soil. He obtained a linear change in the capacity of the condenser as a function of all moisture contents except low ones. Cashen[14], using another type of condenser, studied its capacity with soil blocks between the plates. He obtained rather irregularly shaped curves difficult to explain in terms of soil moisture.

Laboratory experiments were conducted by the author to determine whether the change in the dielectric constant due to a given increase in moisture content is the same for a comparatively dry soil as for a relatively wet soil. Samples of some results on sand ground to various degrees of fineness appear in Fig 4. Reliable laboratory measurements are not easily made because of the difficulty in securing uniform packing of a given sample at different moisture contents. The departure of the points from the average curve may be attributed to this cause. It is interesting to note that the slope of the curve is greater at low moisture contents. This means that a given quantity of water when distributed evenly through the soil produces a greater change in the dielectric constant of comparatively dry soil than it does in the same soil when relatively wet. It will be observed, however, that up to the moisture equivalent the relation is practically linear. The moisture equivalent is approximately the upper limit with which one would have to deal in the field.

[1]Paper presented at a meeting of the Pacific Coast Section of the American Society of Agricultural Engineers held at San Jose, California, January 20, 1933.

[2]Assistant irrigation engineer, University of California.

[3]To be published in "Soil Science."

[4]Lattey, R. T., and W. G. Davies (1931). The influence of electrolytes on the dielectric constant of water. Phil. Mag. 12: 1111-1136.

[5]Lattey, R. T., and O. Gatty (1929). The determination of the dielectric constants of imperfect insulators. Phil. Mag. 7: 985-1004.

[6]Lattey, R. T., and O. Gatty, and W. T. Davies (1931). The temperature coefficient of the dielectric constant of water. Phil. Mag. 12:1019-1025.

[7]Berliner, E., and R. Ruter (1929). Uber dielektrische Messungen als Schnellwasserbestimmung. Kolloid-Ztschr. 47: 251-257.

[8]Burton E. F., and A. Pitt (1929). A new method for the rapid estimation of water in wheat. Canad. Jour. Res. 1: 155-162.

[9]Davies, R. M. (1932). The rapid determination of moisture in seeds and other granular substances. Proc. Phys. Soc. 44: 231-245.

[10]Berliner, E., and R. Ruter (1929). Betrachtungen uber die verschiedenen Arten der Wasserbindung und Beschreibung einer neuen Schnellwasserbestimmung. Ztschr. Gesam. Muhlenwesen 5: 168-173.

[11]Berliner, E., and R. Ruter (1929). Uber Feuchtigkeitsbestimmungen in Weizen und Roggen mit dem DK-Apparat. Ztsch. Gesam. Muhlenwesen 6: 1-4.

[12]Balls, W. L. (1932). Rapid estimation of water-content in undisturbed soil and in bales of cotton. Nature: 129: 505-506.

[13]Balls, W. L. (1932). Capacitance hygroscopy and some of its applications. Nature 130: 935-938.

[14]Cashen, G. H. (1932). Measurements of the electrical capacity and conductivity of soil blocks. Jour. Agr. Sci. 22: 145-164.

Table I. Dielectric Constants* of Various Substances

Water (18°C)	81.07
Methyl alcohol (20°C)	31.20
Ethyl alcohol (20°C)	25.80
Apatite	9.50 — 7.40
Calcite	8.49 — 7.56
Hard-crown glass	6.96
Mica	5.66 — 5.97
Quartz	4.69 — 5.06
Ice (—5°C)	2.85
Asphalt	2.68
Fiber (dry)**	2.5
Paper (dry)**	2.0 — 2.8
Carbon dioxide (760 mm pressure)	1.000946
Air (760 mm pressure)	1.000586
Vacuum	1.000000

*Selected from "Smithsonian Physical Tables," 1927

**Selected from "Electrical Condensers," by Philip R. Coursey, 1927, Pitman and Sons.

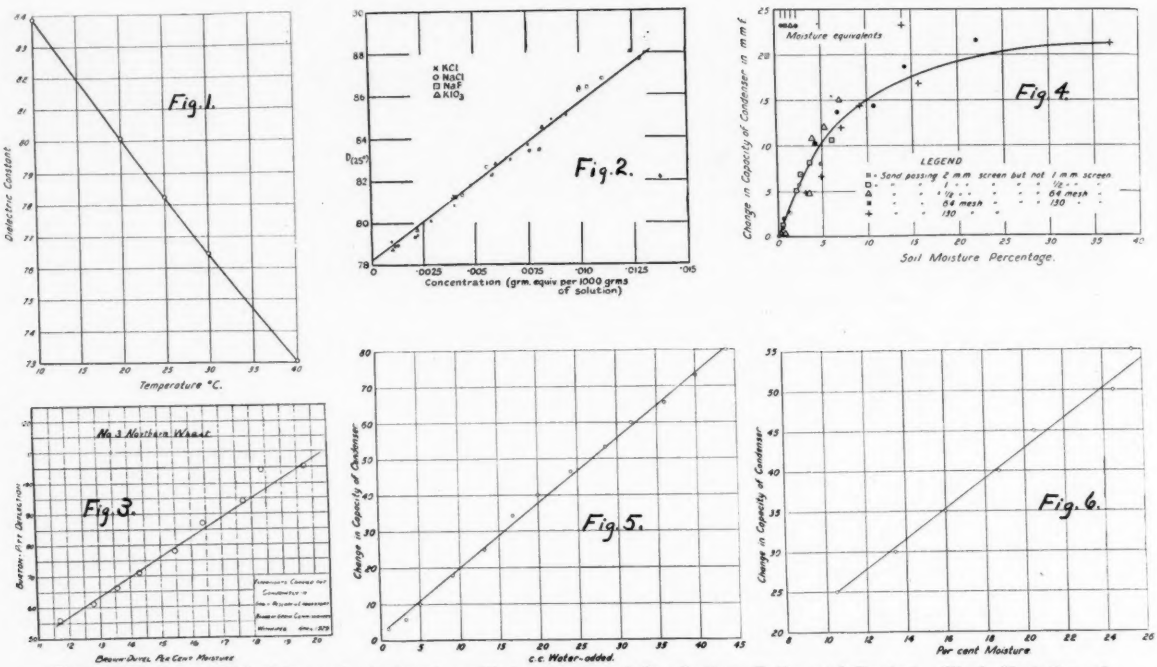

Fig 1. Variation of dielectric constant of water with temperature (after Lattey, Gatty, and Davies). Fig 2. Variation of dielectric constant of solution with concentration (after Lattey and Davies). Fig 3. Results of moisture determinations in wheat with Burton-Pitt apparatus compared with Brown-Duvel method (after Burton-Pitt). The deflection used here should be interpreted as a change in capacity of the condenser used. Fig 4. Change in capacity of a condenser having sand with varying amounts of moisture as the dielectric medium. The material was ground to different degrees of fineness. Moisture equivalents of these sands are shown at the top of the graph. Fig 5. Variation of capacity of a condenser, having dry loam soil between the plates, with variation in amount of water added. Fig 6. Change in capacity of condenser with moisture content as determined in the field on clay loam

In another condenser used, dry loam soil was placed, the change in capacity being noted as water was added. In this case all the soil that was moistened was wetted to its maximum water-holding capacity, while the rest remained dry. These results are shown in Fig 5. The linear relation holds here also, indicating that the increase in capacity of the condenser is proportional to the water added to the soil. This linear relation might be expected in view of the results show in Fig 4, since practically all the water in the soil reported in Fig 5 is held rather loosely.

Another condenser was devised which could be used on undisturbed soil in the field. The results on a clay loam are shown in Fig 6. None of this soil was below the permanent wilting percentage. More work now being carried on by the author, in both the laboratory and the field, is intended to make the method practical for field determination of moisture content.

SUMMARY

A brief discussion summarizes the findings of various investigators regarding dielectric methods of measuring the amount of water in grains, grain products, cotton bales, and soils. The effect of temperature and concentration of solution on the dielectric constant is also discussed.

Spacing of Row Crops in the United States

(Continued from page 242)

knife, disk, blade, duckfoot, spring tooth, scrape, scratch, and shovels of various kinds as follows: double point, bull tongue, slip point, spear head, twisted and narrow shovels from 1 in up to 4 in in width.

The most common spacing between the rows of the four most important crops grown is: Corn, cotton, and grain sorghum, 42 in; potatoes, 36 in. The other row spacings vary from 10 in for green peas to 240 in in the case of some watermelon growers. Some effort has already been put forth in California under the leadership of Ben D. Moses, agricultural engineer of the University of California, to standardize the width of planting row crops. They have been trying out the decimal system, using 10 in or multiples thereof for the various spacings. If we consider the spacings of crops grown over the entire United States, it would seem that the increment might be in multiples of 5 in. If the 5-in increment was used, an examination of the two columns on spacings in Table I would show that in most cases the row spacing would need to be changed only one or two inches to conform to this system. It would seem that herein lies the problem upon which the Committee on Row Crop Investigation should concentrate its efforts, namely, that of attempting to bring about a standard increment in the width of spacing row crops. The Committee will appreciate suggestions from any source in carrying on this program.

A.S.A.E. COMMITTEE ON ROW CROP INVESTIGATIONS

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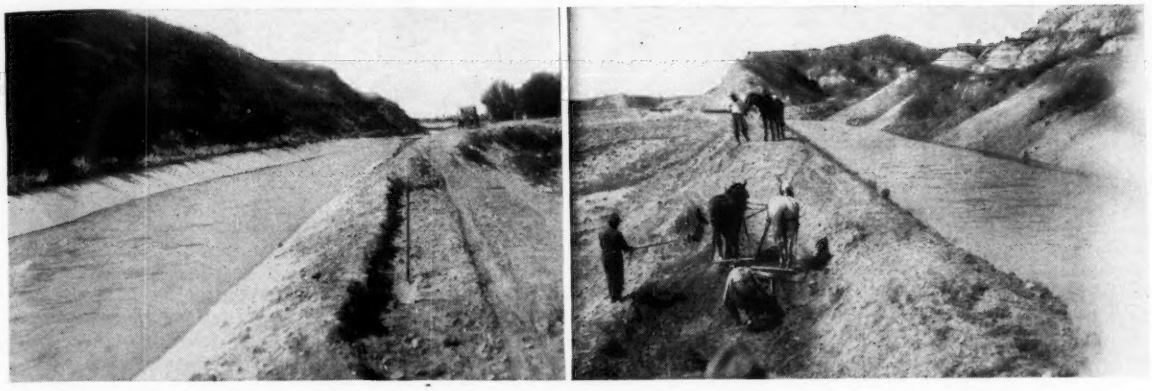


(Left) This view shows a section of an irrigation canal bank that is beginning to settle and slide. (Right) This shows the making of repairs to a sliding irrigation canal bank

Operating Problems on the Federal Irrigation Projects[1]

By George O. Sanford[2]

DURING the 31 years of its existence the Bureau of Reclamation of the U. S. Department of the Interior has constructed 27 projects, in the arid section of the United States and is now delivering water to approximately 2,000,000 acres of land. On these projects, 42,500 rural homes have been established with a population of 177,000 people. An additional population of more than 500,000 is registered in the 227 cities and towns that have come into existence almost entirely as a result of the construction of these projects. Nearly $200,000,000 has been spent on this work and 22 per cent of this sum has already been repaid. The average gross value of crops on the different projects has ranged all the way from $10 to more than $200 per acre, with an average for all projects during the past ten years of record of $38 per acre. This brief statement gives some idea of what has thus far been accomplished.

With the passage of the Reclamation Act in 1902, an engineering organization was immediately assembled to take charge of construction work. The first project was started in 1903 and others rapidly followed. In 1906 work had been advanced so that water could be delivered to 40,000 acres of land, and in 1908 nearly one-half million acres was under irrigation. The speed with which construction work was pushed brought many new problems to be solved, but another class of difficulties confronted the officials when the canals were first operated. It was impossible to find a large force of men experienced in this work, but on most projects the problem was solved by placing this new duty under the supervision of the engineer who had been in charge of construction. The first operation and maintenance conference was held in Yuma, Arizona, early in 1908. One man was present who had been operating canals and delivering water to a large area of land, and, based upon his experience, plans were outlined for operating the twenty projects to which water was to be delivered that year.

When the contractor finishes his job, he may leave something that looks like a canal, but notwithstanding all the care that has been taken in constructing embankments, puddling backfill around structures and lining porous sections with concrete, there is still much work to be done before a large canal can be made to carry water without excessive losses. Such losses occur principally in sections where the subsoil is gravelly and frequently in rock cuts that have been shaken by heavy charges of explosives. The solution is to sluice in fine material. When this cannot be done economically, selected soil is hauled in dump wagons, thrown into the water and washed down into the pervious material until the leaks are made reasonably tight. In special cases, it may be necessary to deposit a blanket of fine soil to a depth of 4 to 6 in. compacting it with teams and rollers. In other cases, it has been necessary to put in expensive concrete lining to prevent excessive losses.

As the bottom section of the canal tightens up, the quantity of water is increased and, as higher levels are reached, greater care has to be taken to see that leaks do not develop. During this process of priming the canals, it is necessary to maintain a constant patrol in order to prevent breaks or serious damage to the canal structures. One of the principal sources of trouble comes from burrowing of pocket gophers that find the moist canal banks ideal places for carrying on their operations. On projects that are infested with these pests, it is a continual fight to get rid of them and they are usually responsible for most of the breaks that occur in the canals.

Another serious problem connected with the operation of new canals is the settlement of embankments, particularly where the canal has been built along a sidehill location. Seepage from the canal saturates the ground, and material that was in stable equilibrium when dry begins to move and assume a flatter slope. While the remedy is often expensive, these difficulties are eventually cured and the canal put in good condition. In one case that came under my supervision, a circular section about 100 ft in diameter, just below a high embankment, began to settle shortly after the canal was first operated. The first year the outer portion of the canal embankment dropped about 6 ft, and with the settlement the material below began to bulge and slowly move down the slope. This pocket of clayey soil continued to settle for a period of 5 years. Each year it was replaced by dumping coarse gravel at the top, and in this small area over 5,000 cu yd were deposited before settlement ceased. No difficulties were experienced in operating the canal, and, although this is rather an exceptional case, it gives some idea of what may happen when large canals are first operated.

It is always the main canal that causes the greatest concern. When there is a break, all of the lands are with-

[1]Paper presented at a session of the Land Reclamation Division of the American Society of Agricultural Engineers during the 27th annual meeting of the Society held at Purdue University, Lafayette, Indiana, June 1933.

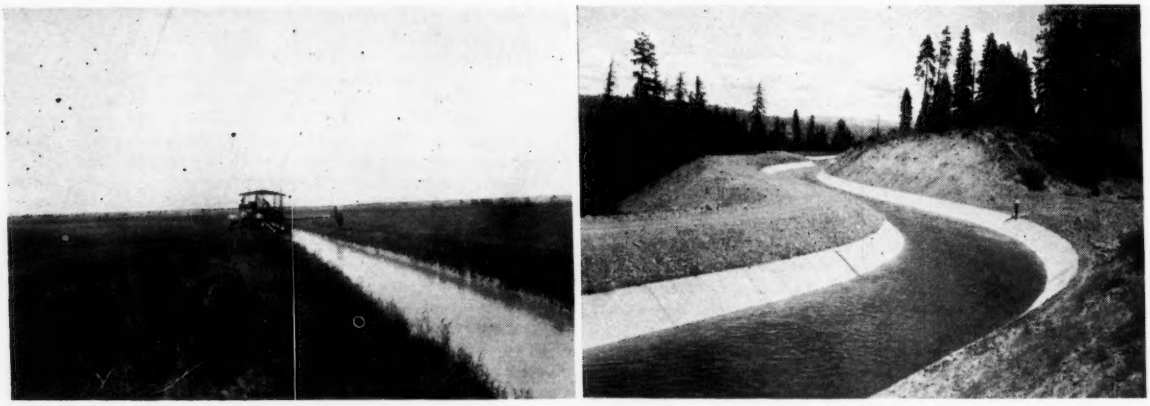
[2]Chief, engineering division, Bureau of Reclamation, U. S. Department of the Interior.

out water until repairs can be made and under the most favorable conditions it is from three days to a week before the full quantity of water is back in the canal. Breaks in the lateral system are not serious as these ditches can be quickly unwatered and repairs made within a short time.

Some of the major problems that confront the superintendent in putting a large canal system into operation have been described. The delivery of water presents problems of another class, as it brings the management into direct contact with the human element. As one drives over a large irrigation project, sees the canals flowing full of water, he gives little thought to the manner in which the quantity may have been determined, or how the water is delivered to the many hundred farms that make up the large projects. These canal systems are designed to deliver all the water that is needed to produce profitable crops, and yet no canal system is constructed large enough to deliver water to all of the farms at one time. Therefore, water has to be delivered on a rotation schedule, carefully worked out, so as to facilitate the economical operation of the system, and usually such rotation schedules run from five to seven days on and then follows an equal period when the water is off. If it is desired to have water delivered to a certain farm during the time when it is available, a written order is sent in to the project office or handed to the ditchrider who reports the order to the office that night. With this information at hand, a schedule of quantities and deliveries is made up for the ensuing day. The gate tender at the head of the canal is notified how much water he is to turn in at the head, which quantity is based upon the sum of all of the individual deliveries plus an estimated quantity to allow for seepage and other necessary losses, and, in many cases, these losses may reach about one-third the total quantity diverted into the system. Each ditchrider is furnished with a list of the deliveries that he is to make and is instructed how much water he is to take out of the main canal. In all cases his problem is to make all of the deliveries ordered and have enough to carry through to the last man on the ditch with only a small allowance for waste. The quantity delivered to the farms may vary from 1½ or 2 cfs on small tracts where the water has to be handled with a great deal of care, to as high as 15 cfs where the border check method is used and where the surface has been prepared to cover the land in the shortest possible time. On most projects the water is handled in an efficient manner when the ground can be covered with an average application of about 6 in in depth, that is, one acre-foot of water will wet 2 acres of land, but sometimes, through carelessness or lack of attention to the water, two and three times this amount may be used. In order to prevent excessive use of water, it is one of the provisions of the reclamation law that while the annual operation and maintenance charge shall be based upon the actual cost of each year's work, the charge per acre shall be fixed so as to return the total cost and with the fixed charge there shall be delivered a stipulated quantity of water, usually based upon the average requirement of the project. Where water in excess of the prescribed amount is used, an additional payment is required. This method results in some restriction being placed upon the excessive use of water. In all cases, water is measured at the point of delivery to the individual farm, usually over a weir, and a daily record is kept of the quantity delivered. On some projects monthly statements are sent out showing the total delivered to date. Records are also kept of the quantity diverted into the canal system, the total delivered, and the quantity that may be wasted at different sections of the system. From these records, the quantity lost by seepage is estimated.

On fully developed projects where storage reservoirs have been constructed for conserving the flood discharge and applying the water to the highest possible use, the operation of such a system becomes a highly complicated matter, as it is necessary not only to operate the canals but also the river system itself. Prior rights must be respected, and there must be a determination of the percentage of natural flow and also the quantity that must be released from the storage reservoirs to supply the needs of the entire valley. In sections where water is very valuable and where the success of the community depends upon the quantity of water that can be made available for irrigation purposes, the determination and limitation of water rights becomes a very intricate matter. On one of the federal projects where steps are being taken to determine and define such rights and thus avoid expensive litigation, there are sixteen different kinds of water described in the preamble of the stipulation that has been prepared. This gives some idea of how difficult and involved this question of water rights may become.

Many of the early reclamation projects were built for the purpose of delivering water to vacant public land which had to be taken up under the provisions of the homestead law and the water rights paid for under the provisions of the reclamation law. When the lands were first opened to homestead entry any citizen possessing a homestead right could file an application. The settlers on these projects came from nearly every section of the United States. They arrived on the projects with high hopes and ambitions, ready to make whatever sacrifices might be necessary to establish a home under the ditch. They were strangers one to another, and it was but natural for them to look to the representatives of the United States for advice as to what they had to do and how they



(Left) A view showing how lateral irrigation canals may be cleaned with a Ruth dredger, which permits cleaning to be carried on with water in the ditch. With this equipment the cleaning can be done at about one-half the cost when men and teams with scrapers are used. (Right) the main canal of the Kittitas division of Yakima (Washington) federal irrigation project recently constructed by the U.S.D.I. Bureau of Reclamation. It shows the precautions taken to build the canal in a safe location

could best make productive farms in arid sections that heretofore had produced only sagebrush and cactus. The engineers helped the new settler lay out his farm and construct the ditches that were required to deliver water to all of the irrigable land. On some projects experienced irrigators were employed to help the new water user irrigate his crops. Assistance was also given in constructing ditch-making implements and land-leveling devices. There were always plenty of problems brought to the project superintendent in connection with the development of these new farms. Most of the settlers came from the humid sections where they could carry on operations wholly independent of their neighbors, and it took some little time to instill in the minds of such water users that irrigation was, to a considerable extent, a community enterprise, and the success of one was dependent to a large extent on the success of his neighbor.

The federal system was built to deliver water at the high point of each farm, and, while in theory an irrigator should be able to water all of his land without waste, it was practically impossible to do this, particularly during the first few years, and waste water became a very serious problem, as the regulations prescribed that each entryman must construct his own waste ditch. As water must flow down hill, it meant that the man above had to join with the neighbor below in the construction and maintenance of such ditches as might be necessary to provide an adequate outlet to some natural drainage channel or a large ditch that had been constructed by the government. There were times when serious troubles arose, law suits were threatened, and now and then some of these troubles were settled by direct action on the ditch bank. Nearly all cases were reported to the project superintendent, who had to use his best efforts to bring about a peaceable settlement. As the years went by these difficulties dropped into the background and were finally taken care of to the satisfaction of all concerned.

SOME ASPECTS OF DELIVERY OF WATER TO LANDOWNERS

On all federal government projects water is delivered upon the request of the landowner, who is not permitted to operate his headgate nor turn water onto his land, although under emergency conditions he may close the headgates so as to give him an opportunity to make repairs to his farm ditches. When water becomes a little short and there is a heavy demand for water to save a burning crop, there is a very strong temptation to turn water out of the ditch regardless of whether one is entitled to it. As in the case of the wilds of Alaska, "Where the law of neither man nor God runs north of fifty-three," so in an irrigated section the man who has heretofore been a law-abiding citizen feels that he is acting within his sacred rights and breaks no law when he takes a little stream of water from the government ditch, and, even in such cases, the most important matter in his mind is to avoid breaking the eleventh commandment, namely, "Thou shalt not get caught." In all my experience in such cases I have never considered it advisable to resort to arrest and prosecution, although in nearly every state in the arid West the law prescribes that taking water and using it on the land without legal authority shall be considered as prima facie evidence of guilt. In such cases, the man usually reasons that as he is taking the water from the government the small quantity can do no harm. He overlooks the fact that every second-foot of water flowing through the ditch is there to be delivered to one or more of his neighbors; that he is taking the valuable property of another farmer; and that such unlawful appropriation may result in serious damage to the neighbor's crops. When the right viewpoint is impressed upon the mind of the man who is tempted to help himself to water, it is usually possible to prevent a repetition.

The difficulties of maintaining a steady flow in all sections of the canal system have been briefly outlined. The man at the end of the ditch is the one who gets it coming and going. If the weather is hot he may be short of water sometime during the day. If an unexpected rain occurs his head ditch may be flooded out. Experienced irrigators are well aware of the troubles that confront the man on the end of the ditch. This idea was impressed upon me in a very strong manner during a conversation in which I took part many years ago out on one of the pioneer canals in Wyoming. There were three of us present and the subject under discussion was religion. One was a Morman, one a Gentile, and the third had yet to be heard from. When he was asked to declare himself he said, "My religion is to live on the head of the ditch," and somebody added "Blessed is the man who knows what he wants and how to get it."

The project superintendent has a particularly favorable opportunity to study human nature. The new settler is striving to move rapidly along the road to prosperity. Some are always ready to take some short cut; to get the government to do something that should be done by and at the expense of the individual. Others are ready at all times to take advantage of a neighbor. But it has been my experience that this class comprises the minority. The majority of the water users intend to play fair with their neighbors and shoot square with the government, paying their obligations when they become due and helping wherever they can in community activities. Bad leadership has been responsible for most of the troubles that have arisen in the administration of reclamation projects. Necessary concessions frequently have been granted, but in some cases the ink on the contract has not had time to dry before plans are started to avoid making payments on the due date.

TWO SOURCES OF FINANCING FEDERAL IRRIGATION PROJECTS

The money that is used in constructing these projects comes from the sale of two of the natural resources of the western states—land and oil. It is used to establish a permanent source of wealth—agriculture—and the money so spent is to be returned, without interest, and used in building other projects or extending aid to established and developed projects that need some assistance. The machinery that must be operated to carry out the provisions of the reclamation law is somewhat complex, but there is one wheel that must be kept turning, and that is the wheel that brings back the money. When that ceases to revolve, the machine ceases to operate. Keeping this wheel revolving in the right direction is one of the trying tasks that has confronted all administrative officials. At first it was the duty of the project superintendent to make collections from the individual water user. It was never a pleasant task, and it was always unpopular, but it had to be done, and it has been carried on with a high degree of success as the total amount collected from water users during the time the projects have been operated, including both construction and annual operating charges and miscellaneous collections, is nearly $105,000,000.

It has been the policy in recent years to build the projects, put them in good operating condition, and turn them over to the water users. This policy is based on the theory that local government is the best and it has worked out to the advantage of both the projects and the Bureau. The collection of annual charges which are levied and collected as county taxes, has also been taken over by the local organizations, and this method results in far less objection on the part of the water users than was raised when the government collected from the individual. Twenty projects or divisions of projects have been so transferred and provision has been made for the transfer of six more in the near future.

As one views the results from a proper perspective, the picture is, on the whole, satisfactory and pleasing. Mistakes have been made, a small percentage of money has been spent that will never be returned, but in the homes that have been established on these irrigation projects, people are living, not in affluence, but in comfort, and the present demand for irrigated farms is considerably in excess of the supply.

Tests of Laminated Bent Rafters (Part II)[1]

By Henry Giese[2] and Elmer F. Clark[3]

IN THE previous paper (Part I)[1], the results were given of some tests relating to the comparative strength and stiffness of several types of bent rafter construction. Beams composed of five 1x4's and six 1x3's nailed only, nailed and bolted, and nailed, bolted, and glued were placed in a testing machine and compared with solid timbers of the same dimensions. These tests were undertaken in an attempt to determine practicable methods of improving the bent rafter type of barn roof construction in order to reduce the sagging common to such barns.

The tests previously reported showed that the application of casein glue increased the strength and stiffness of the laminated beams, making them approximately comparable to the solid beams.

Two points should, however, be considered in making the comparison. First, the glue was applied rapidly, as might be done in barn construction. A strip approximately one-half the board width was coated and no particular effort was made to secure a perfect glue joint. The glue was expected only to carry the horizontal shear developed between the laminations. Second, the laminae in the beams were not all continuous throughout the entire length of the beam but were spliced approximately as might be expected in barn construction.

The tests reported herein were carried on to determine the quality of the glued joints after the lapse of a year. The specimens were stored on the concrete floor of an unheated building and under a leaky roof, and consequently subjected to rather severe humid conditions.

Since some of the specimens were damaged in the previous test, it was necessary to remove the damaged portions. Fig 1 shows the original construction of these specimens. They were 12 ft in length, and the tests were conducted on a 10 ft gage length with an overhang of one foot and a concentrated load applied at the center. By cutting 2 ft out of the center to remove previous fractures (Fig 1), it was possible to get a specimen 5 ft long.

The apparatus used in the tests is shown in Fig 2. The beam was supported on a bearing plate in which a groove was cut to rest on a round pin across the top of a 6x6-in column. The other end was supported by a clevis suspended from the scale beam of the Buffalo scales with the same type of bearing. The scales were sensitive to 2 lb and had a maximum capacity of 5100 lb.

The load was applied to the beam by means of the micrometer screw at the end of the scale beam.

The specimens were tested with a 4-ft gage length allowing a 6-in overhang on the ends. An initial load of 40 lb was applied to take out what slack might be in the apparatus, after which the load was applied in 40-lb increments for the laminated unglued specimens and in 200-lb increments for the laminated glued and solid specimens.

The beams were loaded progressively to the point where the deflection was approximately one-half the total calculated deflection that would cause failure, and retrogressively applied by the same increments. Three such tests were made on the beam. The last progressive loading was continued until the rafter was fractured, the maximum loading capacity of the apparatus reached, or the extension limit of the screw prevented further loading. The progressive and retrogressive loading gave a fatigue similar to that caused by wind loads.

From the data obtained, a stress strain diagram was constructed for each group of specimens. The points were plotted for each specimen in the group and an average curve drawn for all the plotted points. The curve for each specimen in a group varied little from the position of the average curve of that group; hence, the average curves only are shown in Fig 3.

The fatigue shown in Fig 4 is representative of the unglued specimens. After the second progressive loading it will be noted that little additional set occurred. Additional tests beyond the third showed this to be negligible. It is interesting to note that the curve for the retrogressive loading, as may be expected, falls under the progressive loading curve. This is explained by the fact that it takes wood a little time to return to its original position after being deformed. The results of the tests were generally comparable to those of the previous test although changes in moisture content of the wood make direct comparisons difficult. Shorter beams and consequent increase in horizontal shear resulted in some failures from that cause as are subsequently reported.

Group 1. (See Table I.) The flattening of this curve indicates that the laminations slipped on each other. None of the specimens failed at the extension limit of the screw.

Group 2. This curve coincides with that of Group 1 for the first three plotted points then continues higher on the graph, indicating a greater stiffness for this group. None of the specimens failed at the extension limit of the screw.

Group 3. The specimens of Group 3 did not show as great a stiffness as did Groups 1 and 2. This is due to the fact that there were no bolts in this group. However, the general shape of the curve conforms very closely to that

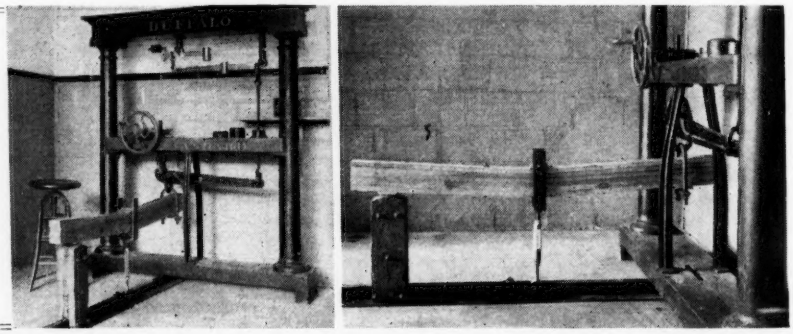


Fig 2. Two views of the apparatus used in the Iowa tests of laminated bent rafters

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[1]Journal Paper No B115 of the Iowa Agricultural Experiment Station (Project No 23). Released for first publication in AGRICULTURAL ENGINEERING. Part I appeared in the January 1932 AGRICULTURAL ENGINEERING, Vol 13, No 1, pages 11-13.

[2]Professor of agricultural engineering, Iowa State College, Mem. A.S.A.E.

[3]Research fellow in agricultural engineering, Iowa State College. Jun. A.S.A.E.

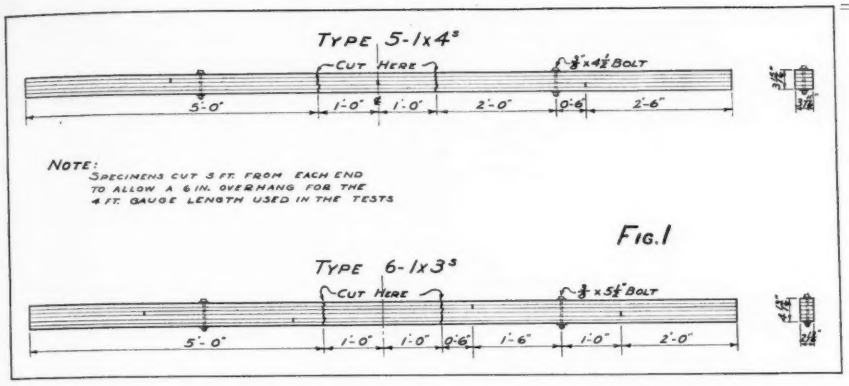
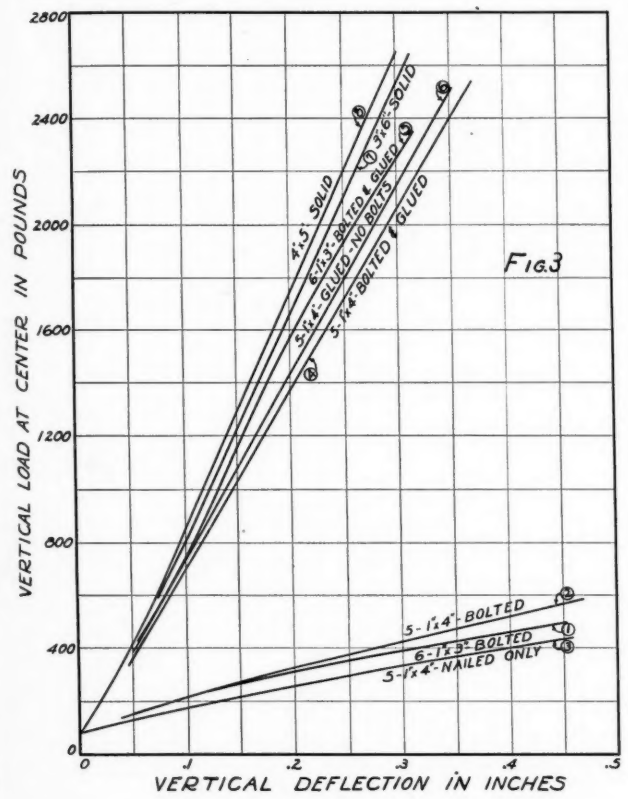
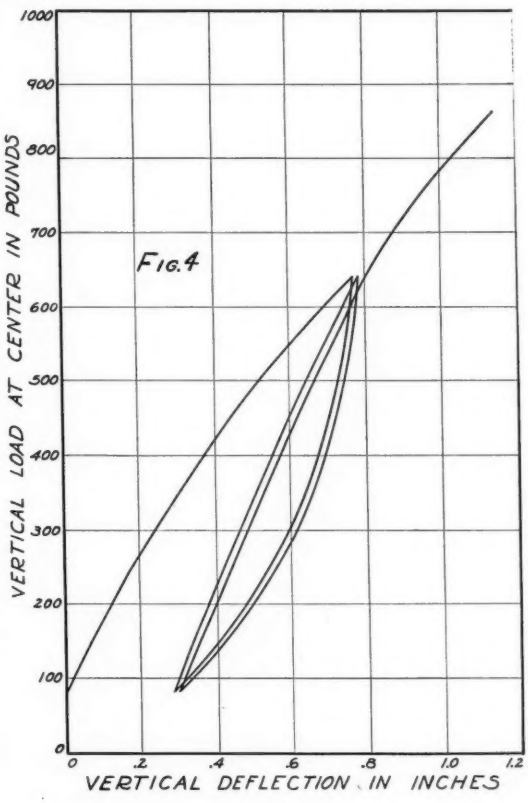


Fig 1. This illustrates the method of cutting constructed test specimens

Fig 3. A composite graph showing the stress-strain diagram for each group of specimens in the test

Fig 4. A fatigue curve for unglued laminated bent rafters





of the preceding groups. None of these specimens failed at the extension limit of the screw.

Group 4. The specimens in this group showed characteristics very much different from those of the preceding groups. The fatigue tests indicated that the specimens returned very nearly to their original position when the load was reduced to 40 lb. The diagram is nearly a straight line and its position indicates a greater stiffness than the preceding groups. Four out of five of these specimens were fractured. Three of the four failed on the bottom course at a knot or other defect. One failed at the glue joint on the bottom course. Specimen 11A was loaded to the maximum loading capacity of the apparatus without failure.

Group 5. This curve approaches nearly to those of the solid specimens. The curve, however, is not a straight line as are those of the other groups of glued specimens. This may be attributed to the fact that the material used in the construction of the rafters contained defects and that more defects showed up in testing this group than in any of the other groups. Four rafters failed at glue joints. Fig 2 illustrates specimen 13-B. Note the pencil mark about 8 in to the right of the clevis. This shows that the second glued joint failed because of horizontal shear and the laminations slipped over each other nearly ½ in. The third board from the bottom failed in tension one inch to the left of the clevis. When the glue joint broke, the left end of this board was held by the bolt and glue, and the right end to the board above by the glue. Since it was then on the bottom of the beam, it was caused to fail.

The failing of the glue joint was a typical failure in this group. One specimen in this group deflected to the extension limit of the screw and another was loaded to the maximum capacity of the apparatus.

Group 6. The curve of this group is nearly the same as that for Group 4, except that it shows a greater stiffness. Specimen 13B failed at the second and third glued joints and 16A and B failed at a knot on the lower course.

Table I. Rafter Specifications

Group	Specimen	Type	Nails	Bolts	Glue
1	1A-B, 2A-B, 3A-B	Lam. 6 - 1x3s	2 - 8d per ft	1-⅜" (detail)	None
2	4A-B, 5A-B, 6A-B	Lam. 5 - 1x4s	3 - 8d per ft	1-⅜" (detail)	None
3	7A-B, 8A-B	Lam. 5 - 1x4s	2 - 8d per ft	None	None
4	9A , 10A-B, 11A-B	Lam. 5 - 1x4s	2 - 8d per ft	1-⅜" (detail)	0.10 lb per spec.
5	12A-B, 13A-B, 14A-B	Lam. 6 - 1x3s	2 - 8d per ft	1-⅜" (detail)	0.10 lb per spec.
6	15 B, 16A-B	Lam. 5 - 1x4s	2 - 8d per ft	None	0.10 lb per spec.
7	17A-B, 18A	Solid 3x6s			
8	19A-B, 20A-B, 21A-B	Solid 4x5s			

Group 7. The solid specimens which composed this group indicate a greater stiffness than any of the preceding groups. Two specimens were loaded to maximum capacity of the apparatus and did not fracture. One specimen failed in tension, 4 in to the left of the center.

Group 8. This group showed the greatest stiffness of any of the groups. All the specimens were loaded to the maximum capacity of the apparatus without a fracture.

In order to compare the stiffness of the various groups, it becomes necessary to choose a deflection which would actually occur in a barn roof. As noted in the previous paper[1] on this subject, some tests were made on a model to determine the deflection, and it was concluded that 2-in difference in deflection was a maximum value for a 10-ft section of a rafter in a roof which had settled at the ridge. The 2-in difference in deflection for the 10-ft section of a rafter is comparable to 0.26 in for a 4-ft length. From the above we consider that 0.26 in is the maximum difference in deflection likely to occur in a 4-ft section of a rafter as a result of the roof settling at the ridge.

In analyzing the composite graph, the curve of Group 3 was given an index value of "1," and the other groups expressed as a ratio to that group. The values thus obtained are recorded in Table I. Since the maximum difference in deflection considered is 0.26 in, a value of 0.13 in was taken as the average difference in deflection.

Groups 1 and 2 show a greater stiffness than Group 3. The ratios 1.18 and 1.27, respectively, indicate that although there is a saving of material in using six 1x3's, there is a slight loss in stiffness as compared to 1x4's. Stiffness is added by using bolts in the construction of the beams not glued.

The glued specimens were much stiffer than the unglued ones. The stiffness ratios for Groups 4, 5, and 6 were 5.92, 6.70 and 6.20, respectively.

The use of glue in the construction of the six 1x3's type of rafters showed an advantage in stiffness over the five 1x4's in contrast to the comparison of the unglued specimens.

Bolts are important in the construction of glued rafters, only as they may assist in securing a better glue joint.

The results show that the 4-by-5-in solid beams were stiffer than the 3-by-6-in solid beams. Since the moisture content greatly affects the stiffness, the 4-by-5-in beams, being thicker, had probably not become as fully saturated as the 3-by-6-in beams; also the 3-by-6-in beams had been damaged more from last year's tests.

One factor of interest in these tests was the ability of the glued joints to carry horizontal shear. On account of the comparative length, none of the original beams failed for this reason. In changing, however, from a 10 to 4-ft gage length, shear becomes a more important factor.

The glue was applied by means of a brush on a strip down the center of the specimen, covering about half its width, after which laminations were nailed and some also bolted.

The maximum horizontal shear for a simple beam, which is subjected to a concentrated load at the center,

Table II. Results of Tests for Deflection

Group	Spec. No.	Maximum load (lb)	Maximum deflec. (in)	Remarks	13" deflec. Load	13" deflec. Com. Stiff.	26" deflec. Load	26" deflec. Com. Stiff.
1	1-A	940	1.22	*	240	1.23	352	1.18
	1-B	960	1.14	*				
	2-A	1040	1.14	*				
	2-B	880	1.18	*				
	3-A	1030	1.22	*				
	3-B	880	1.17	*				
2	4-A	1120	1.14	*	240	1.23	380	1.27
	4-B	1040	1.14	*				
	5-A	1000	1.10	*				
	5-B	1020	1.22	*				
	6-A	1040	1.12	*				
	6-B	1040	1.10	*				
3	7-A	880	1.18	*	195	1.00	298	1.00
	7-B	800	1.16	*				
	8-A	880	1.20	*				
	8-B	880	1.16	*				
4	9-A	3840	0.64	‡	850	4.35	1765	5.92
	10-A	5120	0.77	‡				
	10-B	4000	0.56	‡				
	11-A	6000	0.84	†				
	11-B	3600	0.46	‡				
5	12-A	5200	0.54	‡	970	4.97	1995	6.70
	12-B	2800	0.46	‡				
	13-A	3200	0.60	‡				
	13-B	2800	0.50	‡				
	14-A	6000	0.71	†				
	14-B	4000	1.02	*				
6	15-B	5200	0.66	‡	920	4.72	1850	6.20
	16-A	4800	0.75	‡				
	16-B	4000	0.63	‡				
7	17-A	6000	0.75	†	1030	5.28	2180	7.32
	17-B	6000	0.71	†				
	18-A	5200	0.73	‡				
8	19-A	6000	0.68	†	1100	5.65	2275	7.64
	19-B	6000	0.68	†				
	20-A	6000	0.71	†				
	20-B	6000	0.68	†				
	21-A	6000	0.68	†				
	21-B	6000	0.67	†				

*Extension Limit of Screw
†Maximum Loading for Apparatus
‡Fracture.

Table III. Results of Horizontal Shear on Glue Joint

Group No.	Specimen No.	Maximum load at center (lb)	Maximum horiz. shear (lb sq in)	Remarks
4	9-A	3840	198.0	Did not fail. Extension limit of screw.
	10-A	5120	264.0	Fracture at bolt.
	10-B	4000	206.2	Fracture at knot on lower course.
	11-A	6000	309.5	Did not fail. Maximum load for apparatus
	11-B	3600	185.6	Failed at first glue joint
5	12-A	5200	288.7	Failed at second glue joint.
	12-B	2800	155.5	Failed at fourth glue joint.
	13-A	3200	177.7	Failed at third glue joint
	13-B	2800	155.5	Failed at second glue joint.
	14-A	6000	333.7	Did not fail. Maximum load for apparatus.
	14-B	4000	222.0	Failed at third glue joint
6	15-B	5200	268.1	Failed at second and third glue joints
	16-A	4800	247.5	Fractured board on lower course.
	16-B	4000	206.2	Fractured board on lower course.

is at the neutral axis. This value for any simple beam of rectangular cross section is:

$$S = \frac{3}{4}\,\frac{P}{bh}$$

Where P is the total load, b is the width of the beam, h is the depth of the beam, and S is the unit maximum horizontal shear.

Using the above formula, the maximum horizontal shear values in Table II were determined from tests made on the glued beams.

RESULTS OF TESTS

Groups 4 and 6 (five 1x4's)

1. Two specimens failed at glue joints.
2. Four specimens failed by fracture of board in the lower course.
3. One specimen loaded to maximum capacity of apparatus.
4. One specimen deflected to extension limit of the screw.
5. Low unit shear, 185.6 lb per sq in.
6. High unit shear, 309.5 lb per sq in.
7. Average unit shear 269.3 lb per sq in.

Group 5

1. Five specimens failed at glue joints.
2. One specimen loaded to maximum capacity of apparatus.

(Continued on page 255)

Artistry in Agricultural Engineering Doorway

"THIS beautiful doorway is more than a means of ingress and egress; it is an open sesame to the wealth that is Agricultural Engineering." So reads the opening sentence of the description of the doorway shown in the accompanying picture, which happens to be the entrance of the new agricultural engineering building at the A. & M. College of Texas. The following description is of particular interest and significance to agricultural engineers:

"In the center over the door is the coat-of-arms of the Agricultural Engineering Department. The sun for power, the river for irrigation and drainage, the grain for agriculture, and the sickle for machinery, crowned by the distaff which stands for the home, and thus for farm buildings. The four Latin words, 'potentia' (power), 'aqua' (water), 'machinae' (machinery), and 'edeficia' (buildings) give the four branches of the profession, covering the four divisions of agricultural engineering, namely, drainage and irrigation, farm power, farm machinery, and farm buildings. The horns of plenty surrounding the coat-of-arms typify the goal of the true agricultural engineer—prosperity and fullness of life. The four small plaques on either side of the coat-of-arms represent the various groups of farm machinery—the hoe (soil cultivation), the plow (soil preparation), the flail (crop processing), and the sickle (harvesting). The two designs just below the coat-of-arms stand for farm waters, irrigation, and drainage (on the left), and the mechanic arts of man (on the right). The other two designs alongside these, with their barns and silos, represent farm buildings.

"The door itself is of hand-wrought iron of such delicate beauty and fragile, graceful design as to belie the solid metal from which it is made. The agricultural engineering monogram is the center of interest in the upper half of the design and is lighted by a specially designed fixture that throws intriguing shadows in the pattern made by the light. The two light standards in front are also hand-wrought, even to the serpent, and are as lovely as they are useful.

"The small border in stone around the doorway is an interesting design with field rats gnawing on heads of grain sorghum and ears of corn. The large, outside design depicts the boll-weevil, well known, and equally well hated of farmers, and a series of cotton bolls and cotton leaves.

"S. C. P. Vosper, architectural designer in the office of the college architect and well known for work in designing the Medical Arts Building and Scottish Rite Cathedral in San Antonio, Texas, conjured from his fertile brain these whimsical and lovely symbols of our profession and, as an artist, he may be justly proud of his handiwork. Theodore Voss, of San Antonio, Texas, who did the ornamental work in the exquisite Church of the Little Flower in San Antonio and many other beautiful buildings, took an artist's dream and with infinite patience and care, coupled with the skill of seeing fingers, fashioned that vision in metal. Geno Bernasconi, a native of Italy and a member of the King's Guard during the World War and now reputed the best modeler in Texas, made the models for the designs on this door.

"Cut in marble on either side of the steps are two couplets which sum up, in the words of two poets of long ago, the needs for and aims of agricultural engineering:

The hardy plowman's tools
We next must know,
Which wanting we can
Neither plow nor sow.
—Vergil

To teach
The stream a better course,
To till the wild,
And drain the fen, and
Stretch the long canal.
—Dyer

"Hugo Villa, at one time sculptor-in-chief for Gutzon Borglum, said, after having gazed with rapt attention upon the completed doorway, 'It is beautiful in its proportion and ensemble.'

"This door is open, day in and day out, as an invitation to all—friends, comrades in the profession, students seeking knowledge, and to the world that is looking for well-trained, fully equipped men. Welcome!"

Preservative Treatments of Post Woods[1]

By Deane G. Carter[2]

A STUDY of the comparative value of water-soluble salts and other preservatives in the treatment of post woods was begun in 1926 at the Arkansas Agricultural Experiment Station[3]. In the period of seven years during which treated woods have undergone field tests, the failure of specimens has been sufficient to indicate definite progress in the results of preservative treatment. Check pieces, untreated, have failed almost completely while the more adequate treatments are almost entirely sound.

The project consisted of preservative treatments with zinc chloride, sodium fluoride, sulphur, motor oil, spray solutions, and creosote. All treatments were by open-tank processes, with the objective of finding suitable low-cost preservatives, adapted to use in home treatment, and reasonably effective in field tests. It was intended to compare the relative value of the treatments rather than the service life of full-sized posts. This report is based upon tests of 330 specimens set in the field and inspected annually.

The experimental pieces were oak and pine, 1½ in square and 36 in long. Small specimens are less difficult to treat, the cost for materials and labor is less, more thorough treatment is possible, and much more uniformity in the wood is afforded than would be possible with full-sized posts. The length of 36 in with a setting of 24 in in the ground covered the range of most rapid decay in posts. It was believed that the smaller cross section area would decrease the time required for complete failure, thus giving comparable data in a much shorter period than with full-sized posts. In the study it was found that failures occurred quite consistently beginning in the second year. For purposes of comparison it appears that the small pieces are satisfactory.

Oak and pine are the most common woods available for posts in Arkansas. Neither is highly resistant to decay. The oak used was clear red oak, and the pine was clear, sapwood, shortleaf yellow pine. Both woods responded to preservative treatment. The pine absorbed a greater amount of preservative material in most of the tests, and failure of treated pine was delayed by a year or more, as compared to oak pieces receiving similar treatments. Untreated check specimens failed at approximately the same rate. Table I shows the rate of failure of treated and untreated pieces.

The check pieces failed 97 per cent in the seven-year period, the median failure for oak and pine occurring in the fourth year. The median failure of the treated oak occurred in the sixth year, and of pine in the seventh year, with 23 per cent of the oak and 33.4 per cent of the pine sound at the end of seven years.

The principal object of the study was to determine the value of water-soluble salts (zinc chloride and sodium fluoride) when used in open-tank processes. Creosote was used because of its recognized value as a preservative. Lime sulphur and lubricating oil emulsion spray solutions, sulphur, and used motor oil were believed by some to be worthy of consideration. Altogether fifteen lots of specimens were included in the comparison. Table II shows the number of failures by years for each treatment, and the percentage sound at the end of the period.

While the number of specimens is quite small for some of the treatments, the data give rather definite indications of comparative values. The used of insecticides and fungicides as wood preservatives is apparently not satisfactory. While initial failures were delayed by a year or two, no definite increase in durability was evident. Used motor oil and sulphur offered fair resistance to decay. Of the water-soluble salts, zinc chloride gave the most satisfactory results. Creosote gave practically complete protection.

The zinc chloride treatments used on 102 pieces showed absorptions ranging from 0.054 to 1.81 pounds of dry zinc chloride per cubic foot of wood in the various treatments. A correlation of +0.25 between life and absorption indicated practically no variation due to quantity of chemical absorbed.

It was noted that six specimens steeped in a 7.5 per cent solution of zinc chloride for one hour per inch of thickness and allowed to remain in an oil bath overnight showed no failure. Likewise six specimens given a one-hour heating treatment in oil and oil bath overnight showed no failures. The summary of treatments using motor oil is shown in Table III.

These data may not be taken as conclusive since only 36 specimens are included. It is interesting to note, however, that specimens treated by the shorter processes in which oil was used remained sound, and as the treating period was increased the failure of specimens increased directly, showing complete failure for pieces treated 24 hours per inch of thickness.

In the zinc chloride treatments, all specimens given a treatment of one hour per inch of thickness showed 29 per cent failure, compared with 39 per cent failure for pieces treated 2 hours per inch. The single failure of creosote-treated pieces occurred in the lot given the longest heating treatment. These results raise the question of a possible destructive action due to longer periods or higher temperature of treatments.

[1]Research Paper No 310, Journal Series, University of Arkansas. Released for first publication in AGRICULTURAL ENGINEERING.

[2]Professor of agricultural engineering University of Arkansas. Mem. A.S.A.E.

[3]Barr, Harold T. "Research on Wood Preservatives." AGRICULTURAL ENGINEERING, Vol 8, No 7, p 176 (July 1927).

Table I. Service Tests of 159 Oak and 171 Pine Post Specimens Showing Percentage of Specimens Failing Each Year

Condition	Material	Per Cent of Specimens Failing by Years							Sound at 7 years per cent
		1	2	3	4	5	6	7	
Treated (all methods)	Oak	0	0	0	26.2	17.4	12.0	21.4	23.0
	Pine	0	0	0	10.9	13.7	13.0	29.0	33.4
Untreated	Oak	0	12.1	12.1	45.5	18.2	6.0	3.0	3.0
	Pine	0	3.0	18.2	36.4	15.2	15.2	9.0	3.0

Table III. Failure of Oil-Treated Specimens

Process	Preservative	Length of Treatment	Per cent failure	Per cent sound after 7 years
Steeping	Zinc chloride and oil	1 hour per inch and oil overnight	0	100
Heating	Oil	1 hour per inch and oil overnight	0	100
Heating	Oil	2 hours per inch and oil overnight	33.3	66.6
Heating	Oil	4 hours per inch and oil overnight	66.6	33.3
Steeping	Oil	12 hours per inch	83.3	16.6
Steeping	Oil	24 hours per inch	100.0	0

Table II. Comparative Value of Preservative Methods as Indicated by Years of Service of Wood Specimens

Treatment	Material	Number of Specimens: Failed by years 1	2	3	4	5	6	7	Sound after 7 years	Total treated	Per cent sound after 7 years
Check (no treatment)	Oak		4	4	15	6	2	1	1	33	3.15
	Pine		1	6	12	5	5	3	1	33	3.15
Lime sulphur spray	Oak					4	4	4	0	12	0
	Pine				1	5		6	0	12	0
Lubricating oil emulsion	Oak				4	2	1	3	2	12	16.60
	Pine				4	2	1	4	1	12	8.30
Sodium fluoride and oil	Oak					3			0	3	0
	Pine						1	1	1	3	33.3
Sodium fluoride and borax	Pine						3	1	2	6	33.3
Sodium fluoride, 3.5%	Oak				5	1	1		2	9	22.2
	Pine				3	2	1	2	1	9	11.1
Sodium fluoride, 2.5%	Oak				2	2		6	2	12	16.6
	Pine				3			6	3	12	25.0
Used motor oil	Oak				3	3	1	2	6	15	40.0
	Pine				4	1	1	1	8	15	53.3
Sulphur (molten)	Oak					1	1	1	3	6	50.0
	Pine					3	1		2	6	33.3
Zinc chloride and borax	Pine					1	1	4	0	6	0
Zinc chloride, 5%	Oak				1		5	3	9	18	50.0
	Pine						4	7	7	18	39.0
Zinc chloride, 7.5%	Oak				1			4	10	15	66.6
	Pine								10	15	66.6
Zinc chloride, 2.5%	Oak				2			2	11	15	73.3
	Pine							5	10	15	66.6
Zinc chloride and oil	Oak								6	6	100.0
	Pine										
Creosote	Oak							1	8	9	89.0
	Pine								9	9	100.0

Barr[4] found that certain chemical compounds, soluble in a weak acid, were highly toxic to fungi of the principal wood-destroying organisms, and Long[5] reports the use of arsenious oxide in impure granular form in contact with the post wood below the ground line.

In the present study it is proposed to enlarge the tests to include toxic salts in the wood, contact treatments, a study of time of processing, and increase the number of pieces in each treatment to about one hundred, to afford a more accurate check on the results to date.

SUMMARY

1. This paper reports the results of seven years' field tests of preservative methods on post woods.

2. It is possible to use specimens smaller than full-sized posts to determine the comparative value of preservative methods.

3. The use of spray materials, suitable as insecticides and fungicides is of little or no value in the preservation of wood in contact with the ground.

4. Oak and pine, untreated, tend to fail at about equal rates; however, pine responded somewhat better to preservative treatment, due apparently to the greater absorption of preservative.

5. Used motor oil in various processes indicated a range from complete protection to complete failure. Six lots involving 36 specimens indicated that the longer the processing time, the greater the failure.

6. Creosote gave almost complete protection.

7. Aside from creosote, zinc chloride and used motor oil give results sufficient to justify further investigation.

8. Future tests will include a study of the value of toxic chemicals as post preservatives.

[4]Barr, H. T. "Laboratory Studies on Toxic Chemical Control of Wood Destroying Fungi." AGRICULTURAL ENGINEERING, Vol II, No 4, p 161-163, April 1930.

[5]Long, J. D. "New Wood Preservative Methods." University of California College of Agriculture, Mimeograph release. January 10, 1932.

Reduction in Labor Requirements Due to Machinery

POWER and machinery on farms caused a reduction in labor requirements in wheat and corn production of more than 50 per cent in some localities in the last 30 years, and a considerably higher percentage since 1840, according to a survey made by the Bureau of Agricultural Engineering, U. S. Department of Agriculture.

With the sickle and flail approximately 47 man-hours were required to cut, bind, shock, thresh, and clean an acre of wheat. The binder and thresher reduced the labor to about 6 man-hours, and the combined harvester-thresher, together with motor trucks for hauling, reduced the labor to about 2 man-hours.

In 1855, at least 10 man-hours were required to cultivate an acre of corn with a one-horse shovel plow. The one-row riding cultivator has cut this time to about 5 man-hours, and a two-row cultivator to 2 man-hours an acre. To husk 40 bushels per acre of corn by hand from the standing stalk today, including hauling to crib, requires from 6 to 10 man-hours. With a two-row, tractor-operated corn picker, not more than 2 man-hours may be necessary.

Experiences with General-Purpose Tractors[1]

By R. U. Blasingame[2]

THE end of 1932 completed several years of research work at Pennsylvania State College with general-purpose tractors. To begin with, in 1925 there was only one cultivating tractor on the market. One of this type was used for the production of corn, oats, wheat, hay, and potatoes. It was soon discovered that this tractor was perfectly capable of producing hay and small grains. Bulletin No. 238, entitled "Farm Power and Labor," was published giving the results of this work. The research program was then divided into several specific projects concentrating the effort upon the production of corn and potatoes, and the development and improvement of a potato harvester, spring tooth cultivators, a power take-off sprayer, spring release overload hitches, weeders, and planters.

This was the beginning of 1929. That year was spent in the development and perfection of several potato machines for the tractor. A power take-off sprayer was built and proved satisfactory. During the same year several weeders were designed and built in cooperation with the manufacturer and adapted to the tractor. Up to this time, the only form of weeder on the market was a horse-drawn implement. The power sprayers up to this date were equipped with engines. The power take-off replaced that power unit. Two-row automatic potato planters were not altogether satisfactory for tractor operations. This was due largely to inaccuracy in planting and to their failure to stand the punishment which rocky land and tractor power imposed. In cooperation with the manufacturer a potato planter was modified to the point that it is now about 96 per cent perfect in planting, and compression springs have been applied to the furrow opener in order to relieve the strain when immovable objects are encountered. It was in the year 1929 that the spring-tooth cultivator was applied to the potato crop.

All of these machines have been further perfected from time to time, until in 1931 it required only 15.29 gal of fuel, 11.06 tractor-hours, and 16.9 man-hours per acre to produce potatoes from the time the plow went into the field until the crop was ready to harvest. During this time the tractor went over the land twenty-four times doing the various operations. It should be pointed out here that in order to have uniform planting the seed potatoes have to be uniform in size. "Seconds" or whole potatoes weighing from 1½ to 2 oz are used. In the past few years this seed has given about 96 per cent planting through the automatic planter. This is probably better than could be done with the assisted feed planter where an extra man is used.

In 1930 a new three-row, general-purpose tractor was employed for corn production. This tractor performed, in excellent shape, in the preparation of the seedbed and in planting the crop. However, when cultivation has begun, it was soon discovered that the spring-trip type of cultivator did not have strength enough to withstand the punishment imposed by the speed and power of the tractor and the rough usage incident to rocky land. The manufacturer supplied a set of spring-tooth cultivators of the half-moon shape. The 40 acres of corn were cultivated twice with these spring teeth without breakage. However, most of the spring teeth were badly sprung out of normal shape. The second year 70 acres of corn were produced with this tractor, and the manufacturer supplied a set of spring teeth. This 70-acre field was cultivated four times with the breakage of only two of these spring teeth.

This was in 1931. The figures on this field were as follows: 7.86 gal of kerosene, 4.64 tractor-hours, and 5.63 man-hours per acre were required to produce the corn up to harvest.

Stony land extends over parts of Minnesota, Wisconsin, as well as through many sections of the East. Along with the spring-tooth cultivator development, overload release plow hitches came in for their share of consideration. This was absolutely necessary because tractor plowing in stony ground with a solid hitch was not profitable. Hitches were adopted which release the plow from the tractor when an obstacle is encountered. A rod was provided to the plow clutch instead of a rope, and a lifting handle attached to the plow drawbar. By these means the plow can be coupled to the tractor without the operator getting off the tractor.

This arrangement changed tractor plowing from a doubtful job to one of economy. One can hardly time an experienced operator, with an ordinary watch, from the time he jerks loose until he is recoupled and over his difficulty. Such accessories not only save time but plow parts as well.

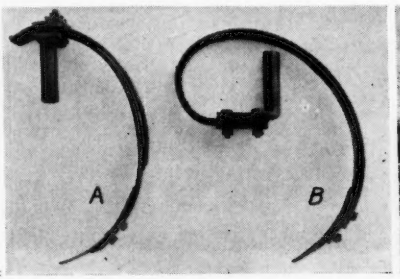
Following close upon the perfection of this equipment, E. G. McKibben designed, built, and tested a clutch throw-out stop hitch in 1931, while employed at Pennsylvania State College. This work was continued by A. W. Clyde, and his article, entitled "A Study of Tractor Stop Hitches," in the March 1932 AGRICULTURAL ENGINEERING, speaks for itself. This stop hitch is ready to be made commercially available when financial conditions bring power farming back.

In the search for a better lifter to prevent the sprayer wheels from injuring potato vines, the late H. B. Josephson discovered that iron rods, placed in a certain way on the McNeese vine guard, improved its operation. Shop rights for the manufacturer's use of this improvement has been sold to one of the well-known full line farm equipment manufacturers.

The foregoing cost figures, no doubt, are somewhat high-

[1]Paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, held at Chicago, November 1932.

[2]Head, department of agricultural engineering, The Pennsylvania State College. Mem. A.S.A.E.



These pictures show developments resulting from the Pennsylvania research work with general-purpose tractors. The half-moon shaped spring tooth (B) proved superior to the other type (A). In the picture of the tractor plow, note the rod to operate the plow clutch instead of a rope, and the handle on the plow drawbar to lift it for coupling to the tractor without having to get off the seat

er than the present power farming records in the corn belt, but land in the East is sometimes more difficult to handle. However, according to the U.S.D.A. Yearbook, the Pennsylvania farmer produces about as much corn per acre as the farmers of the Middle West. The eastern farmer also receives higher prices for his products due to close proximity to New York and other cities. There is still another favorable factor which encourages power farming in Pennsylvania, and that is the ready market for agricultural products. The ten million population in Pennsylvania make an important agricultural state due to the market this vast throng of industrial people normally affords.

Such facts as these naturally encourage farming by the cheapest, quickest, and best methods. The farmers of the East, as a rule, spend much time in merchandising their own products. The farms are small in acreage, but large in investment and production, and, as a rule, are devoted to the production of food for people.

A rather satisfactory plan of general-purpose tractor research has been developed at Pennsylvania State College. It consists of the department of agricultural engineering cooperating very closely with the farm superintendent, Dr. C. F. Noll. The department does not own, nor does it feel that it is essential to own, a farm. On the other hand, the authorities of the institution have, on many occasions, offered any size farm to the department that would be thought desirable. If, therefore, the reseach engineer in agricultural engineering requires a field on which to produce a crop, it is usually furnished by the farm superintendent. The farms department supplies the seed, fertilizer, and sometimes much of the labor in the production of the crop and the proceeds go to the farms department, which is set up for the disposal of farm products. This relieves the department of agricultural engineering of all details incident to crop production, except the field work.

Due to the fact that general-purpose tractor equipment was not of the highest order at first, the authorities of the institution were reluctant to give the department land on which to grow crops. In fact, it was understood that any crops grown with the general-purpose tractors back in 1925 would have to be far enough away from the usual line of travel so as not to be seen. This was a worthy precaution and saved the department of agricultural engineering much embarrassment.

However, these opinions have been somewhat altered as time has gone on, due to the fact that the department of agricultural engineering has produced corn and potatoes comparable in yield and at satisfactory costs.

As the scene opens in 1933, the department of agricultural engineering will produce another crop of potatoes and whatever acreage of corn is consistent with a good research program. Instead of two general-purpose tractors there may be three or four. Two new features will be added to the program:

1. The production of a crop with a tractor designed to burn anti-knock fuel.
2. A conventional type tractor equipped with rubber-tired wheels to do odd jobs.
3. Possibly a one-plow tractor for vegetable gardening.

Tests of Laminated Bent Rafters

(Continued from page 251)

3. Low unit shear, 155.5 lb per sq in.
4. High unit shear, 333.7 lb per sq in.
5. Average unit shear, 222 2 lb per sq in.

CONCLUSIONS

All comparisons of stiffness made in these conclusions are for a deflection difference of 0.26 in at the center of a 4-ft gage length.

1. Beams constructed of five 1x4's averaged 1.27 times as stiff as a rafter of the same construction not bolted.
2. Glued beams composed of six 1x3's were 4.52 times as stiff as one not glued of the same construction.
3. Glued beams composed of five 1x4's bolted and glued were 4.65 times as stiff as one of the same construction not glued.
4. Glued beams composed of five 1x4's glued with no bolts are 6.20 times as stiff as an unglued rafter of the same type.
5. The use of bolts is more important in the construction of unglued beams than glued beams, except that they do improve the glue joint.
6. The fact that the glued specimens compared favorably in stiffness with the solid specimens in both series of tests, indicates that moisture had little effect on the water-resistant glue.
7. Comparing these conclusions with the conclusions of last year's tests, the stiffness of the glued and solid specimens was not affected as much by the change in moisture content as the unglued specimens.
8. Since a fracture usually occurred on the extreme fiber, it is important that the best materials be used on the outer lamination. The lower grade materials may be used in intermediate laminations.
9. The average maximum unit shear at failure was higher for the laminated glued beams of five 1x4's than for the six 1x3's beams.
10. Shear was the determining factor in the bending strength in the laminated glued beams constructed of six 1x3's, whereas stress on the extreme fiber accounted for the largest number of failures in the beams of five 1x4's.
11. The horizontal shearing strength of glue compares favorably to glueing specifications despite the fact that it was applied to a little more than one-half the width of the board and the laminations were nailed together without the use of clamps.

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Raymond Olney, Editor

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In a Time of Change

IN THE current flux of governmental, economic, and social organization, agricultural engineers may be opportunists in a broader and more social sense than ever before.

Always opportunists in using the forces and materials of nature, should we not also be opportunists in molding the alloys of human organization while they are hot; in harnessing the power of the "body politic" while it is amenable?

Social and economic experiments are being tried. What of their agricultural engineering phases? For example, unemployment relief through the regimentation of labor for conservation works suggested definite possibilities to certain agricultural engineers. As a result of their foresight and efforts, soil erosion control is a part of the conservation program, and agricultural engineers are enjoying a real opportunity to further progress in this field.

The development of Muscle Shoals will mean something to agricultural engineers. So will the National Recovery Act. Other portents are in the air. In addition to considering the agricultural engineering phases of larger plans, some agricultural engineers may have new and original suggestions for increased economic and social welfare. If so, there may never be a time when it will be easier to win a fair hearing, and to get backing for ideas which show possibility of improving the general or agricultural status of humanity.

And in the execution of plans touching their fields, agricultural engineers in large numbers will find both individual and social opportunity. It is our responsibility to execute our part in recovery plans so perfectly as to give those plans every possible chance of success.

Governmental routine has been disturbed. Agricultural engineering activities have been hampered at some points, with probable injustice to certain individuals. That is the price drawn from us in return for the new opportunities thrust upon us. Our only choice can be to make the most of our new opportunities.

The current state of flux is a time for agricultural engineers to think broadly but not loosely; to suggest discreetly; to examine critically; and to execute carefully, even more than ever before. Let recovery be not delayed for lack of agricultural engineering foresight, initiative, cooperation, or technical application.

The Error of "Farm vs. City"

WHEN two men, each combining such ripeness of years, wealth of experience, and such natural endowment for evaluating technical achievement in terms of human well being, as do J. B. Davidson of Iowa and William Boss of Minnesota, emphasize the same broad principle in the relations between agriculture and other occupations, it is food for thought not only throughout, but without, our profession. This they did in papers at the Purdue meeting, that of Dr. Davidson having appeared in these pages last July, while Professor Boss' paper is published in this issue.

The fact on which their seasoned judgment agrees as most significant is that agriculture thrives and farmers are well-off when other industries are soundly prosperous. In each case it is more than a vague altruism or unsupported affirmation of the interdependence of occupations. Both men show causal relation by factual study. This type of thinking is in grateful contrast to that displayed by some of the metropolitan press, which commonly concedes as a generality that farm prosperity is helpful to urban industry, but bitterly attacks every specific effort for farm betterment as a holdup of the city consumer.

From the narrow standpoint of demagogic journalism it may be good strategy to ignore the age-old saying that the laborer is worthy of his hire, and engage in interclass haggling over the exchange value of food. To a degree agricultural engineers favor the urban side in this phase of the argument, for engineering strives for such economies in food production as will allow lower costs to the consumer after adequate return to the producer.

But when editors who should know better argue for a return to primitive, high-cost ways of farming, they propose to hurt not only the farm producer but the city consumer. It simply does not make sense that cheaper food can be secured by making its production cost more. All of this is obvious to the point of boredom among agricultural engineers. Where we err is in assuming that it is equally obvious and accepted by others.

Though we are by profession the technicians and not the protagonists of agriculture, we are among the few qualified to state the case for agriculture accurately, conservatively, and convincingly. For the welfare not alone of farmers, but of the whole social and economic fabric, we may properly emulate Professors Boss and Davidson by promoting a better understanding of agriculture's place in the scheme of things. In particular it is our job to show urban people how their interests, both as consumers and as industrialists, are protected by a well-engineered agriculture.

Quantitative Consumer Values

THE paper by Messrs. Davidson, McCuen, and Blasingame on "Appraising Improvements in Farm Machines," together with the report, by the same authors, to which the paper pertains, probably will prove a landmark in broader fields of engineering and economics than the boundaries of our own profession. If agricultural engineering has drawn freely on the sciences and on other branches of engineering, here is something in repayment of the debt.

The quantitative evaluation of consumer values, with reasonable completeness, would be a rather staggering assignment for any class of equipment. Strictly speaking, of course, the consumer of farm machinery puts it to industrial use, but in an industry beset with many variables affecting consumer or user values. The problem was difficult enough to justify the three-fold and eminent judgment summoned to its solution.

Indeed, even a tolerable degree of success by an initial effort in so complex a field is sufficient promise for its refinement of method and increasing success as its practice is continued and extended into other fields. No doubt the authors would disclaim any great originality, but time probably will credit them with a piece of pioneering.

A.S.A.E. and Related Activities

Canadian Agricultural Engineers Elect Officers and Present Program

THE Canadian Section of the American Society of Agricultural Engineers held its annual meeting this year during the World's Grain Exhibition and Conference at Regina, Sask., July 24 to August 5. The membership of the Section also functions as the agricultural engineering group of the Canadian Society for Technical Agriculturists.

During the business session of this meeting, F. L. Ferguson, drainage director, Province of Ontario, Ontario Agricultural College, was elected chairman of the Section; E. A. Hardy, professor of agricultural engineering, University of Saskatchewan, was elected vice-chairman; and L. G. Heimpel, professor of agricultural engineering, Macdonald College, was re-elected secretary-treasurer. These officers will serve for one year, or until the next regular meeting of the section.

The technical program presented at the agricultural engineering session included a number of outstanding papers and addresses, most of them by members of the American Society of Agricultural Engineers. A paper on the mechanization of agriculture in Russia was presented by E. J. Stirniman. "The Effects of Mechanization on Wheat Production" was the subject of a paper presented by L. J. Fletcher, agricultural engineer, Caterpillar Tractor Company. The latter was presented at a combined session of the agricultural engineering and agricultural economic groups, at which also a paper by Dr. J. F. Booth of the Dominion Department of Agricultural Economics dealt with the effects of mechanization on Canadian agriculture in the spring wheat area. E. A. Starch presented a paper on the economics of power used in large and small units. H. K. Wilson, University of Minnesota, presented the results of studies on the suitability of different varieties of grain for harvesting with a combine. J. E. Newman, Institute of Agricultural Engineering, University of Oxford, England, discussed future developments in wheat growing in England.

At the session on July 26, a paper by S. H. McCrory, chief, U.S.D.A. Bureau of Agricultural Engineering, emphasized the tremendous field of research in agricultural engineering. Teaching methods in agricultural engineering was the subject of a paper by J. MacGregor Smith, University of Alberta. Much interest was shown in a discussion by E. A. Hardy, University of Saskatchewan, on the use of heavy fuels in farm tractors. H. E. Murdock, Montana Agricultural College, presented a paper on the various types of big team eveners and hitches in use. G. G. Pearse, J. I. Case Company, and G. D. Jones of the Cleveland Tractor Company, discussed the subject of mechanical power as applied to agriculture. The "Economic Aspects and Controllable Factors in Tillage Operations" was the subject of a paper by G. M. Thomson, Cockshutt Plow Company.

Three papers on seeding equipment included one on seeding wheat in deep furrows by W. C. Andreas, Dempster Mill Manufacturing Co., one on the deep furrow drill by H. B. Dinneen, Minneapolis-Moline Power Implement Company, and the third by W. L. Braley, Oliver Farm Equipment Co.

At the final session of the agricultural engineering group a paper on an Australian combine was presented by A. T. Thom, president, Waterloo Manufacturing Company. A paper discussing the design and the development of the power binder by Guy Bevan, chief engineer, Massey-Harris Company, was of special interest. The subject of the mechanical control of weeds in the spring wheat region was discussed by J. G. Haney, International Harvester Company. Interesting test data on the development of pneumatic-tired tractors for agriculture were presented in a paper by George H. Mystrom, Allis-Chalmers Manufacturing Company. L. G. Heimpel, professor of agricultural engineering, Macdonald College, discussed at the closing session the possible improvements in mechanization of eastern Canadian agriculture. R. P. Frey, University of Saskatchewan, closed the session with an interesting paper on wind electric plants.

Launches Handbook Project

THE Structures Division of the American Society of Agricultural Engineers, not content to rest on its oars after its outstanding accomplishment of this past year, namely, the successful inauguration of the Mid-West Farm Building Plan Service, in which 15 states of the middle west have cooperated in the preparation of a number of farm building plans and in which they will continue to cooperate in the distribution of these plans—the Division now announces the launching of another project of even greater significance and importance to farm building development and improvement. This is a farm structures handbook. This follows an effort on the part of the Division a year ago to reorganize its committee work and to attempt to review best present practice and theory in all phases of farm structures.

Recently a tentative outline of the proposed handbook was sent to members in the structures group of the Society for recommendation and constructive criticism. All members of the Society who are interested in such a handbook are invited to make recommendations, and those who have not received a copy of the tentative outline may secure one from the chairman of the handbook committee or from the Secretary of the Society. The chairman of the committee charged with the responsibility of organizing and directing the handbook project is Henry Giese, and comments on and inquiries pertaining to this handbook should be addressed to Mr. Giese at Station A, Ames, Iowa.

Program Features Announced by A.S.A.E. Group

THE Power and Machinery Division of the American Society of Agricultural Engineers has announced the main program features for the meeting to be held at The Stevens, Chicago, during the international livestock show. On account of the number of subjects demanding attention, and also due to the fact that the sessions will be limited to two hours each, the meeting of the Division this year will be of three days duration, and is definitely scheduled for December 4, 5, and 6.

The first half-day session will be devoted to a symposium on seedbed preparation and tillage, which will consider largely the subject of equipment and the materials therefor. The afternoon session of the first day will deal exclusively with the subject of agricultural wheel equipment, in which rubber tires for tractors and other machinery will be the principal feature.

The forenoon session of the second day will be devoted to a symposium

on agricultural and industrial engines, mainly on important considerations in the design thereof. The afternoon session will follow with a symposium on the very timely subject of agricultural engine fuels.

The forenoon session of the third day is to be given over to a symposium on garden tractors. The program of the final session of meeting has been purposely left open for the time being, so as to provide an opportunity for scheduling certain important subjects that may be presented for consideration of the program committee later on.

Personals of ASAE Members

Ben W. Faber, formerly rural electrification engineer, Westinghouse Electric and Manufacturing Company, will become associated on October 1 with the Elmira Light, Heat and Power Company, Elmira, N. Y., as new business representative.

Joseph L. Greene, formerly connected with the John Deere Spreader Works of Deere & Company in the capacity of draftsman and experimental engineer, has recently become associated with the LaCrosse Plow Works of Allis-Chalmers Manufacturing Company, in experimental and design work on farm machinery. His new address is Kingston Court, LaCrosse, Wisconsin.

Ove F. Jensen has recently become associated with the Ammonia Department of E. I. du Pont de Nemours & Company. His work will be in sales and sales service to fertilizer manufacturers in the Southeast. His headquarters will be in Wilmington, N. C.

A. V. Krewatch has been appointed assistant in rural electrification in the agricultural experiment station and extension service of the University of Maryland. Recently he served as electrical engineer on the National Rural Electric Project.

Necrology

Samuel Fortier (Hon. Mem. A.S.A.E.) passed away at his home in Berkeley, California, August 17, at the age of 78 years. Dr. Fortier was elected to honorary membership in the American Society of Agricultural Engineers in 1923, in recognition of his engineering accomplishments in developing the land and water resources of the west.

Dr. Fortier was a native of Canada and received his master's degree in engineering from McGill University. In 1885 he went west to build wooden bridges and route the Denver and Rio Grande Western Railroad over the Continental Divide. Within a year he became first assistant engineer for the Denver Water Company, which was the beginning of his long and successful career in solving engineering problems in the great irrigation development of the West. For several years he served as engineer or consulting engineer for Colorado, Utah, Montana, and California, designing and superintending waterworks systems and laying out irrigation systems with their water distribution and delivery problems. Not only was Dr. Fortier a pioneer in the establishment of irrigation practices in the West, but there is scarcely an irrigation project of any importance in that part of the country that does not bear the stamp of his counsel, if not of his actual design and construction.

Dr. Fortier joined the U. S. Department of Agriculture in 1899 and served in various engineering positions. In 1907 he was made chief of the irrigation investigations, and in 1921 became associate chief of the division of agricultural engineering of the Department, now the Bureau of Agricultural Engineering. In August 1930 he retired at the age of 75 years.

Dr. Fortier was author of numerous state and federal reports and bulletins on water supply and irrigation. In 1896 he won the Dzowxir medal of the Canadian Society of Civil Engineers for his paper on storage reservoir. In 1912 he was detailed by the Department of Agriculture to assist British Columbia in irrigation practices and legislation.

Dr. Fortier is survived by his widow who lives at 582 Santa Rosa Ave., Berkeley, Calif.

E. Grant Lantz (Assoc. Mem. A. S. A. E.) passed away at Omaha, Nebraska, August 12. He was elected to membership in the American Society of Agricultural Engineers while still a student in agricultural engineering at the University of Nebraska. After receiving his agricultural engineering degree from the University of Nebraska (1924), he joined the agricultural engineering staff at Pennsylvania State College, where he taught agricultural engineering subjects for the next three years. During this time he conducted a survey of farm fires in Pennsylvania for the state bureau of fire protection and the state college, doing both the field work and writing the report. It was rated a particularly outstanding piece of work.

In 1927 he joined the Portland Cement Association at Chicago where he was engaged in promotional work until about a year ago. For several months he was unemployed, but at the time of his passing he was connected with the Minneapolis office of the Portland Cement Association.

While at Pennsylvania State College, Mr. Lantz took a prominent part in the activities of the North Atlantic Section, and during the years of his membership in the Society served on a number of committees and was an enthusiastic and able worker.

Joseph Doty Oliver (Hon. Mem. A. S. A. E.) passed away August 6 at his home in South Bend, Indiana, at the age of 83 years. Mr. Oliver was elected an honorary member of the American Society of Agricultural Engineers in 1921 and was one of the first ten men to be elected an honorary membership in that organization. He was the son of James Oliver, the inventor of the chilled iron plow. He attended Notre Dame and DePauw Universities, and upon leaving school he entered his father's factory in South Bend in the capacity of a clerk to learn the plow business. He was largely responsible for popularizing the chilled plow and other inventions of his father, and for building up the business. When his father passed away in 1908 he became directing head of the Oliver Chilled Plow Works, and continued in that capacity until the company was reorganized and merged with several other farm equipment companies in 1929 to form the Oliver Farm Equipment Company, at which time he was elected chairman of the board of directors. He was active in the affairs of the company practically until his passing. For 18 years he served as a trustee of Purdue University, eight of which he was president of the board.

New ASAE Members

W. J. Agnew, farmer, Walker, Iowa.

Eldon M. Collins, erosion foreman, U. S. Emergency Work Camp P-53, Albia, Iowa.

H. W. Delzell, manager, technical service tire division, B. F. Goodrich Rubber Company, Akron, Ohio.

Transfer of Grade

William J. Godtel, Culbertson, Nebraska.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the August issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Robert B. Hickok, graduate research assistant, department of agricultural engineering, Michigan State College. (Mail) 916 Bensch St., Lansing, Mich.

Roy C. Hubbard, 401 Cummings St., Fort Worth, Texas.

Edward W. Mundie, helper in engineering department, West Virginia Pulp & Paper Co., Covington, Virginia. (Mail) 105 McCurdy St.

H. J. Stockwell, technical advisor, Civilian Conservation Corps, Camp 56-E, Pittsfield, Ill. (Mail) CCC 1660.

W. Albert Towler, Jr., farmer, Charlotte Court House, Virginia.